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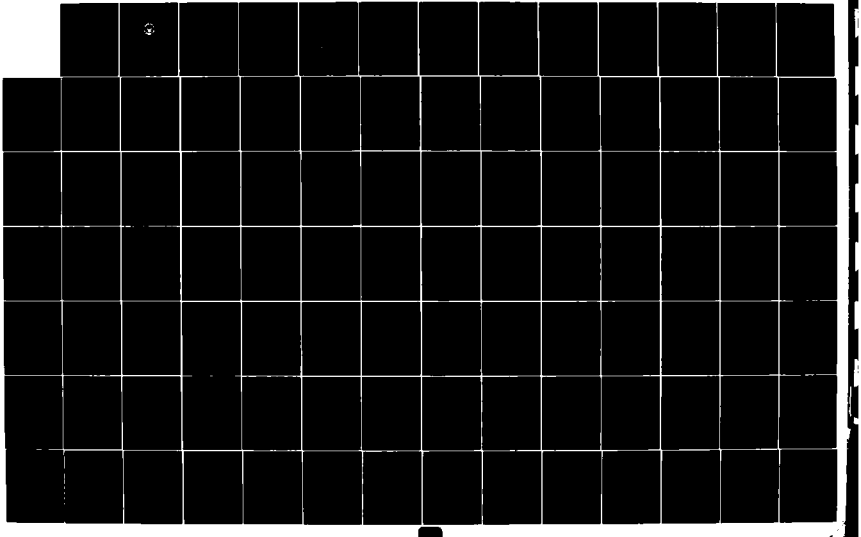

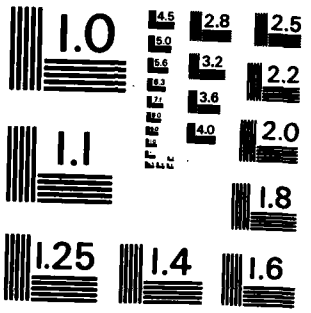

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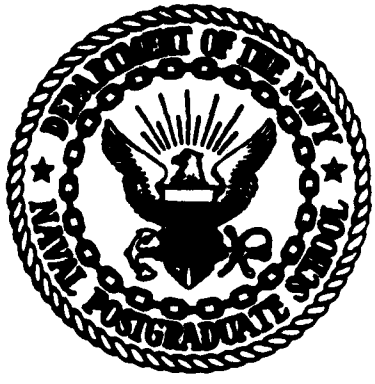

THESIS

MANNING THE ARMY IN 1990

by

Has Slone, Jr.

June 1982

Thesis Advisor: R. S. Elster

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This thesis is a study of the feasibility of manning an 18 division U. S. Army by FY 1990. To accomplish this, aggregate and paygrade requirements were established and a review of manpower supply and demand issues was made. Two manpower scenarios were then developed and used in predicting aggregate and paygrade requirements. Specific predictive information used included personnel attrition, retention, promotion and accession data. The information was processed using an APL program called MANMOD. The program

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Manning the Army in 1990

by

Has Slone, Jr.
Captain, United States Army
B.A., Morehead State University ,1975

Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

This thesis is a study of the feasibility of manning an 18 division U.S. Army by FY 1990. To accomplish this, aggregate and paygrade requirements were established and a review of manpower supply and demand issues was made. Two manpower scenarios were then developed and used in predicting aggregate and paygrade requirements. Specific predictive information used included personnel attrition, retention, promotion and accession data. The information was processed using an APL program called MANMOD. The program is based on Markov Chains and allows projection of personnel supply data into the future (in this case until 1990). The data projections provided predictions on whether present policies will meet future paygrade requirements, or whether changes in policies will have to be made in order to man an 18 division (active duty) Army. The result of this thesis indicates that the personnel supply required to fill 18 divisions will be available, but problems may be encountered in attaining a sufficient number who can qualify in AFQT test categories I-IIIA .

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I. INTRODUCTION

> " It may be laid down as a primary position, and the basis of our system, that every citizen who enjoys the protection of a free government, owes not only a portion of his property, but even of his personal services to the defense of it." [Ref. 1]

Until the late 1960's, the conscription system rested on Washington's statement that tenure in the military was a service to the country, and that citizens had a duty to the nation to offer their service if called. The Vietnam War undermined, at least temporarily, these attitudes. There were many who believed that the involvement of U.S. troops was a disservice to the nation. The result was the movement in 1973 from conscription to the All-Volunteer Force.

The shift from a compulsory to a voluntary system has necessitated dramatic changes within the armed services. In the volunteer armed forces, market considerations have grown in importance. Increasingly, the military has had to face some of the same questions as other employers:

1. How should manpower be recruited, assigned, promoted and separated?
2. What pay is necessary to attract and retain the needed complement of employees?
3. What investment should be made in their training and development?

These questions were not completely disregarded in the past, but they received a lower priority before the All Volunteer Force.

Institutions as large as the U.S. Army do not change over night. History and tradition can not be ignored. Established practices that are vital to the system's basic

functions and those that are merely custom have had to be differentiated. Inherently, then, the on-going transition from a compulsory to a volunteer system involves uncertainties, disagreements, painful adjustments and wrong steps. At best, the ordeal of changing has been painful for the Army.

However, adaptation and change have only just begun. The Army is in the midst of a major modernization program with approximately 200 new systems of all types in some phase of development. These systems are to be introduced over the next ten years (by 1990). Although new weapon systems are its most visible feature, modernization also includes the introduction of many other non-materiel systems, organizational changes and doctrinal modifications which have a collective impact of even greater significance on the force.

With new weapon systems and a changing military strategy, comes realignment and restructuring of the divisions. A major issue then becomes: how many divisions and of what type will be necessary to fulfill the Armys' battlefield strategy in the future.

This paper addresses itself to a scenario in which the active Army will grow to 18 divisions by 1990. Its purpose is to discover if the projected personnel by paygrade increases accompanying the force requirements can be met. Such a study is of potential value to policy-makers and force planners in that it identifies some of the potential problems and feasibility issues involved with a force increase.

To accomplish this thesis, a review was made of past and present data relating to supply and demand issues and policies as they related to the All-Volunteer Force. In particular, data relating to attrition, retention and accession were examined as to their influence upon the past and present manning of the force.

The cost, both financially and operationally, of attrition and low retention rates cannot be minimized when discussing the All-Volunteer Force. The shortage of experienced personnel, especially at the mid-management level, is a matter of concern to the Army leaders and to Congress. Past Congressional policy in the areas of salary, training and personnel management dealt the Army some significant set-backs in the late 1970's, but Congress has recently initiated or is planning changes to correct them.

Beyond questions concerning attrition and retention, is the problem of accessing personnel in the quantity and quality to maintain the Army and allow for needed growth. As this thesis will show, the pool of potential enlistees is shrinking thru 1995 and educational test scores have been decreasing.

An APL program, designated MANMOD, was utilized in this thesis to project personnel accession, retention and attrition data to the year 1990 in order to provide predictions of paygrade shortages or overages in growing to an 18 division force. This model allows the prediction of the impacts of changes in accession, retention, promotion and attrition on future manpower availability scenarios.

Chapter Two investigates the development of force requirements and establishes a growth scenario for a 28 division Army Total Force (active and reserve components). From the force requirements is developed an aggregate enlisted paygrade structure that would be required to support it.

Chapter Three presents the issues involved with manpower supply and demand. It includes a discussion of training issues, quality and the demand implications of increased technological weaponry upon the force.

Chapter Four utilizes the APL program MANMOD to develop two scenarios involved with meeting the growth requirements of 18 active duty divisions. Predictions by paygrade are made using accession, attrition, retention and promotion as variables in the model.

Finally, in Chapter Five, conclusions are made concerning the feasibility of, and possible problems in, manning an 18 division active duty Army force by 1990.

II. MANPOWER REQUIREMENTS

A. INTRODUCTION

In this chapter the Army manpower requirements for 1982 will be established. Then, using 1982 as a base year, projections will be made concerning Army growth and manning through 1990.

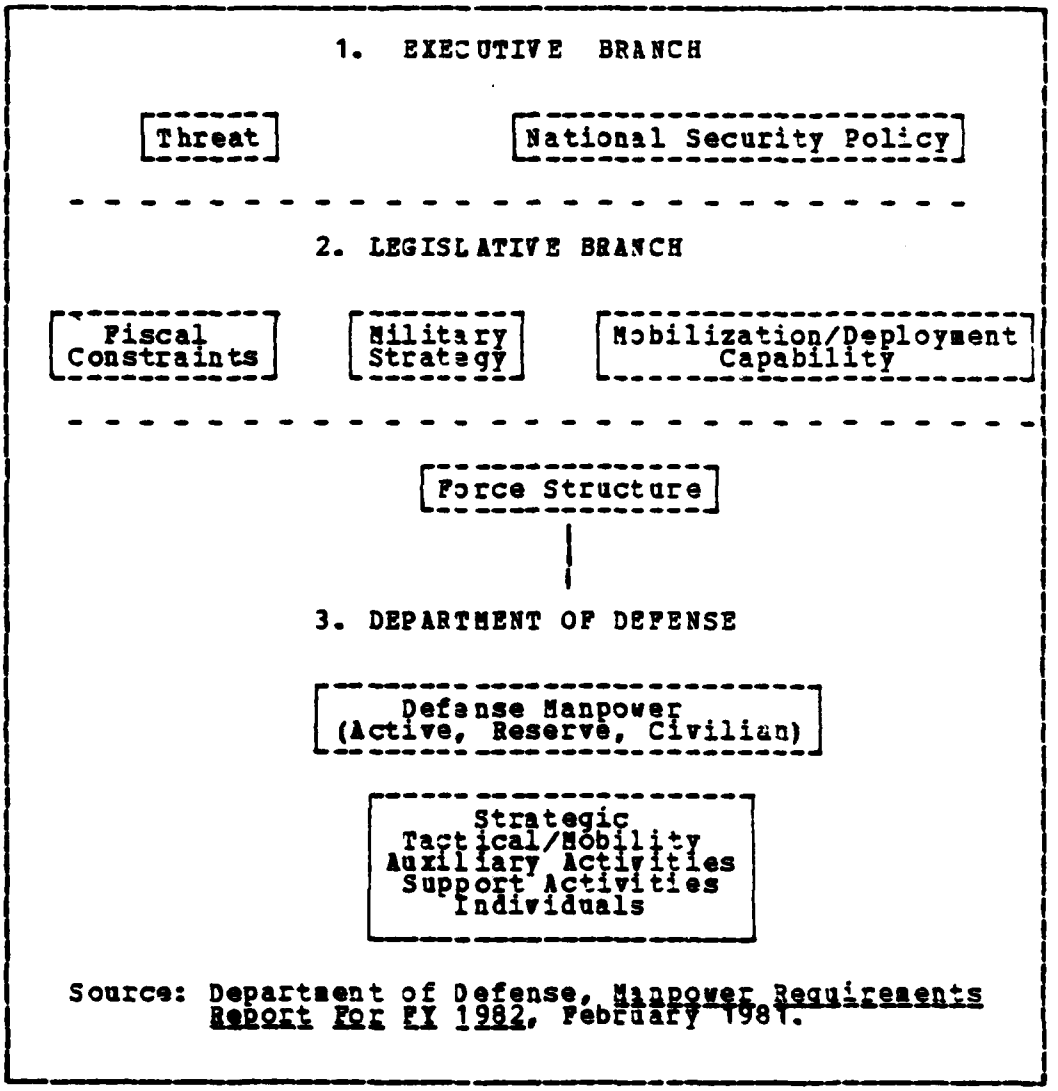
To accomplish this investigation, the Army is examined from the standpoint of paygrade (i.e., E-5, E-6...) with the division used as the major force element.

B. FORCE STRUCTURE

1. Policy and Defense Manpower

> "The basic national security objective is to preserve the United States as a free nation with its fundamental institutions and values intact. This involves assuring the physical security of the United States and maintaining an international environment in which U.S. interests are protected. Achieving this objective is dependent upon the ability to influence international affairs from a position of recognized strength, to fight when necessary, and to terminate conflicts on terms compatible with U.S. national security interests. To those ends, strong and capable armed forces are essential." [Ref. 2]

The National Security Policy is formulated by the Executive branch (i.e., the President, National Security Council, and Secretary of State). Military strategies are then developed by the Joint Chiefs of Staff and the Secretary of Defense using the National Security Policy as a guide. Force structures based on preferred strategies are then presented to Congress, which weighs them against the fiscal and physical capabilities of the nation to obtain an adequate force structure to meet the perceived threat. This process is illustrated in Figure 2.1.



Source: Department of Defense, Manpower Requirements Report For FY 1982, February 1981.

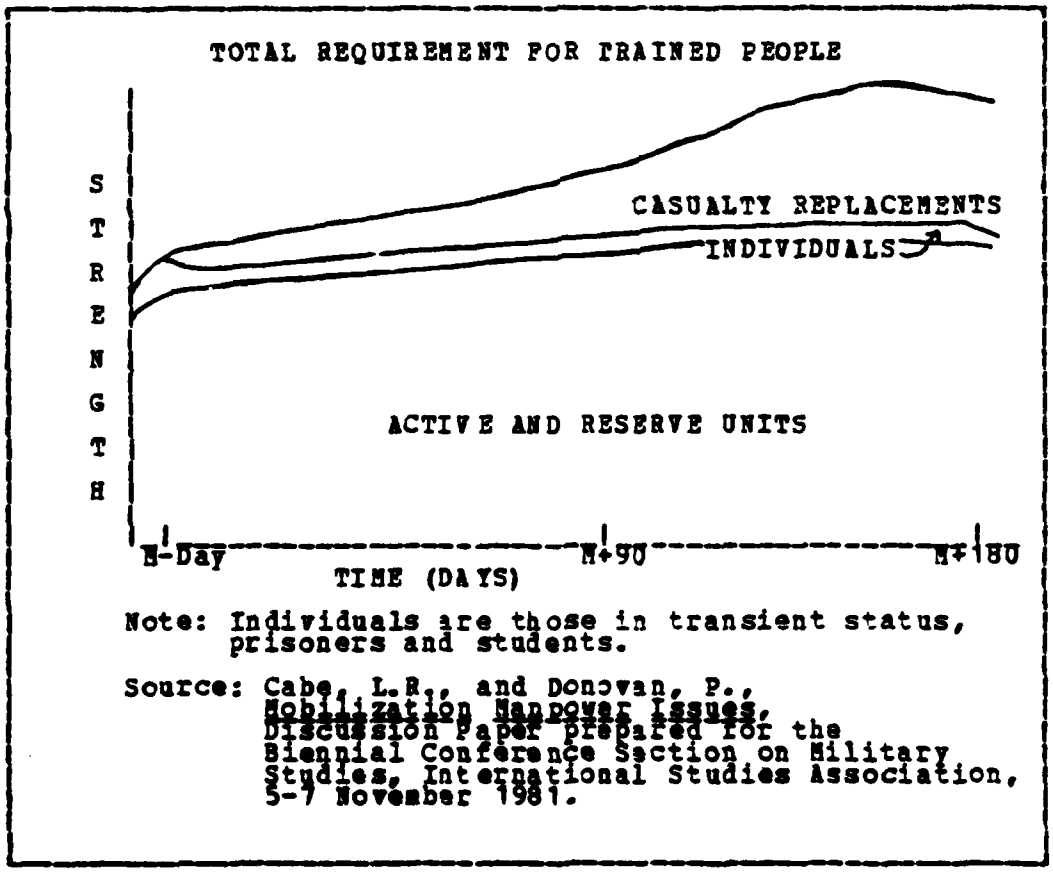
Figure 2.1 POLICY AND DEFENSE MANPOWER

2. Mobilization Requirements

The Army's mobilization needs, as shown in Figure 2.2, are determined from a "worst case" scenario. The scenario envisioned is a conventional war in Europe between NATO

and Warsaw Pact forces. The mobilization force that would be required for such a war would consist of the following manpower pools:

1. units of active and reserve military forces at full wartime strength,
2. personnel not assigned to units who are needed to maintain the forces at wartime strengths plus,
3. casualty replacements, less those who later return to duty.



Note: Individuals are those in transient status, prisoners and students.

Source: Cabe, L.R., and Donovan, P., Mobilization Manpower Issues, Discussion Paper prepared for the Biennial Conference Section on Military Studies, International Studies Association, 5-7 November 1981.

Figure 2.2 COMPOSITION OF MOBILIZATION REQUIREMENTS

3. Mobilization Supply

To supply this force (see Figure 2.3) in a timely manner, the Army must train a large number of people during peacetime and assign them to active and reserve units. There must also be an obligated and trained manpower pool to fill the active and reserve units to wartime strength, and, upon mobilization, to replace casualties until the training support base has been established. Additionally, there is a requirement immediately following mobilization to begin the training of volunteers and inductees to provide additional trained individuals after about four months. These trained individuals will be needed to:

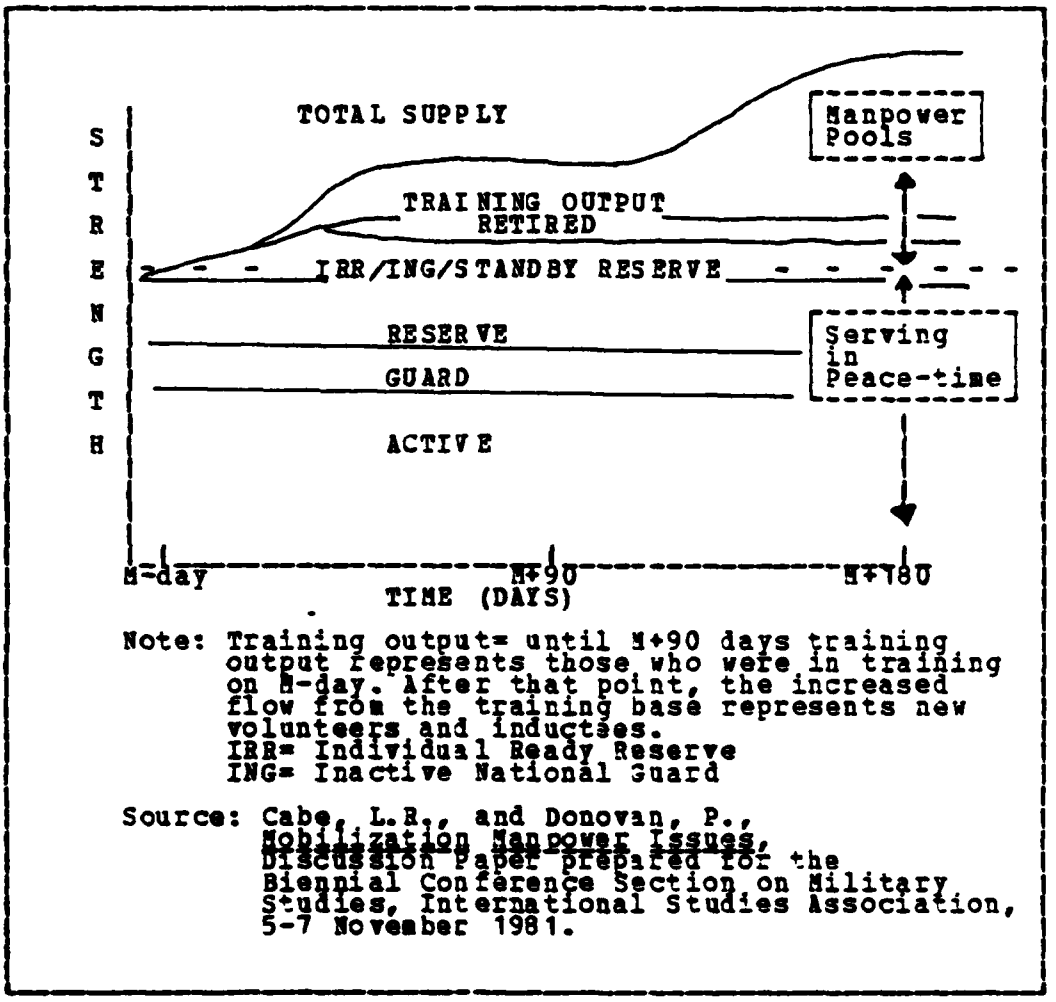
1. replace casualties,
2. fill late deploying units to wartime strength,
3. and to expand the force, if necessary.

The issue of casualty estimation is very complex because of the many estimates that must be made concerning kill ratios and battlefield scenarios. Likewise, pretrained manpower requirements are a politically sensitive issue because of questions as to: (a) Who to count?, (b) How much is enough? The author felt that both (casualty estimation and pretrained manpower) issues were beyond the scope of this thesis, so they will not be further discussed.

The remainder of this chapter discusses the requirements of the Army's active and reserve components in their peacetime configurations.

4. Mission and Composition of the U.S. Army

The peacetime army is composed of active duty Army, Army National Guard (ARNG), and US Army Reserve (USAR) contingents. Each of these can be further described by



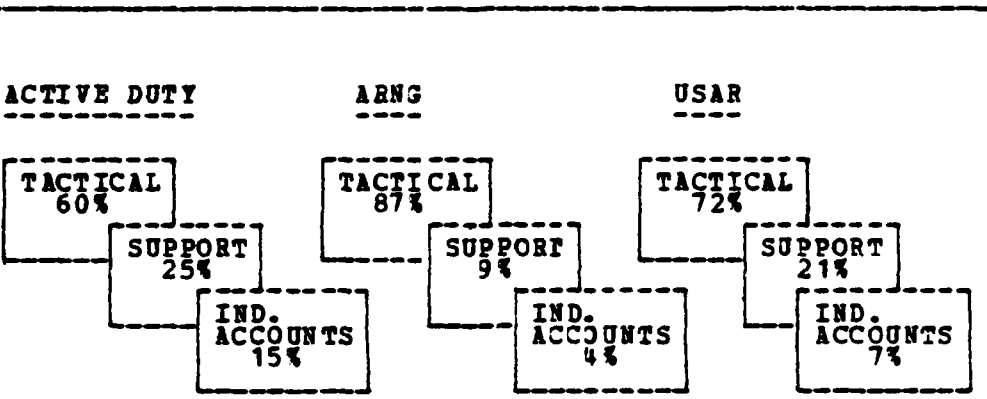
Note: Training output= until M+90 days training output represents those who were in training on M-day. After that point, the increased flow from the training base represents new volunteers and inductees.
IRR= Individual Ready Reserve
ING= Inactive National Guard

Source: Cabe, L.R., and Donovan, P., Mobilization Manpower Issues, Discussion Paper prepared for the Biennial Conference Section on Military Studies, International Studies Association, 5-7 November 1981.

Figure 2.3 COMPOSITION OF MOBILIZATION SUPPLY

assigning their forces into mission categories of tactical, support, or individual accounts. Note the percentages of the assigned Army forces within each contingent depicted in Figure 2.4.

The tactical mission includes combat, combat support and combat service support units. Specifically, those units that would directly support the soldier in the field (i.e.,



Note: Ind.= Individual
ARNG= Army National Guard
USAR= United States Army Reserve

Source: Department of the Army, Program Objective Memorandum : FY 83-87, v. 5, sec. 7, 1982.

Figure 2.4 ARMY MISSION ALLOCATION, BY COMPONENT

armor, signal, military police, etc.). The support mission includes those agencies who indirectly support the soldier in the field, (i.e., intelligence, research and development, schools). And, lastly, individual accounts include those personnel who are transients, prisoners , students or trainees. Note in Figure 2.4 that the greatest percentage of each contingent is tactical.

5. Type of Divisions

The Army uses the division size unit as a basic building block when discussing its tactical force. The Army presently has established 24 such units (active duty plus the reserve components). These units can be further divided into five separate types based on their force authorization (i.e., number of troops by skill) and equipment issue. The five types are:

1. Airborne
2. Airmobile
3. Armor
4. Infantry
5. Mechanized

As can be seen in Table I, there are 16 active duty and 8 ARNG divisions. However, only seven of the 16 active duty divisions are exclusively manned with active duty personnel. Nine of them require infusion of either battalion or brigade size ARNG units to achieve authorized strength levels. Also notice that the USAR is not formed into division size elements. In addition to the above mentioned units, there are 25 separate reserve component brigades, 18 of which are ARNG units.

TABLE I

DIVISIONS BY TYPE

TYPE	ACTIVE		ARNG	
a) AIRBORNE	1		0	
b) AIRMOBILE	1		0	
c) ARMOR	4		2	
d) INFANTRY	4		5	
e) MECHANIZED	6		1	
TOTAL	16	+	8	= 24

Note: The four ARNG brigades designated as roundout units to raise the active duty divisions to authorized strength levels are included in the active totals.

Source: Department of the Army, Program Objective Memorandum, FY 83 - 87, v. 5, sec. 7, Department of Defense, 1982.

6. Paygrade Requirements

The total manpower requirements (officers and enlisted) for active Army, ARNG and the USAR for FY 1982 is approximately 1,426,000. In aggregate, this number tells very little about force structure. However, in Table II, the enlisted force requirements for 1982 are shown by paygrade. Notice that most of the enlisted requirement is concentrated in the lower grades (E1 - E4). This is due to the Army's heirarchical paygrade structure.

TABLE II

ENLISTED REQUIREMENTS BY PAYGRADE (FY 1982)

(000's)

PAYGRADE	E-1,4	E-5	E-6	E-7	E-8	E-9
PERCENTAGE	56.7%	19.2%	13.4%	7.9%	2.2%	0.6%
PEOPLE	700.4	237.2	165.5	97.6	27.2	7.4
TOTAL			(1235.3)			

Source: Department of the Army, Program Objective Memorandum, FY 83 - 87, v. 5, sec. 7, Department of Defense, 1982.

Now that the FY 1982 paygrade requirements have been established and the current division mix defined, the next topic of discussion will involve projecting Army manpower requirements through the year 1990.

C. FORCE PROJECTIONS

1. Introduction

In 1976, the U.S. Army Training and Doctrine Command (TRADOC) began what has now evolved into a major effort to redesign the army for the 1980's. This effort is called Division 86. Division 86 focuses on the Armys' heavy divisions (armored and mechanized). Its goal is to develop the optimal structure for employing the many new hardware systems entering the inventory over the next decade. Division 86 has also served as the medium for developing and institutionalizing a methodology for future force design endeavors. This approach is now being applied to design a future light infantry division (Infantry Division 86) and a conceptual heavy corps (Corps 86). Most recently, TRADOC has begun a study of organizational structures above the corps level (Echelons Above Corps (EAC)). Collectively, these force design initiatives are known as Army 86.

2. Projected Division Growth

Offensive land operations continue to depend on the capability of mechanized forces. However, to meet the strategic objectives of the nation, a proper mix must be established among the types of divisions. The mix should consider the distinct type of advantages offered by each in cost, strategic mobility, firepower and survivability so that future challenges or conflicts may be met successfully.

So the real question is: How many divisions and of what type are needed to counter the nation's perceived threat and to meet its strategic goals in the 1980's?

General E.C. Meyer has stated that the Reagan administration's objectives move the army beyond an objective of 24 divisions, and beyond a national strategy almost

exclusively focused on Europe. He states that an army of 28 divisions of the proper mix would meet the Reagan administration's strategic goals [Ref. 3]. Table III contains the author's perception of a 28 division Total Army mix.

TABLE III

THE AUTHOR'S PROJECTED DIVISION MIX

	ACTIVE		RESERVE COMPONENT	
TYPE	(change)	(1990)	(change)	(1990)
AIRMOBILE	-	1	-	0
AIRBORNE	-	1	-	0
ARMORED	-	4	1	3
INFANTRY	2	6	-	5
MECHANIZED	-	6	1	2
TOTAL		18		10

Note: Change refers to divisions added between 1982 and 1990.
Reserve Component = Army National Guard/U.S. Army Reserve.

Source : Author.

The Army of the future will be lighter, more versatile and more mobile. As a result of Infantry Division 86, it will use highly sophisticated weapon systems and rely on technology to increase its force capability. Because the Army is putting a great deal of emphasis on the successes of the Infantry Division 86 tests (the High Technology Test Bed, 9th Infantry Division), the author felt that growth in the active army would involve the infantry. However, realizing the importance of armor in land warfare, the author also believes that there should be growth in armor strength. Table IV shows this projected growth and projects when it would occur in the author's scenario.

TABLE IV

THE AUTHOR'S PROJECTED DIVISION GROWTH

TYPE OF DIVISION	FY 82	(change)	FY 86	(change)	FY 90
AIRMOBILE	1/0		1/0		1/0
AIRBORNE	1/0		1/0		1/0
ARMOR	4/2		4/2	(0/1)	4/3
INFANTRY	4/5	(1/0)	5/5	(1/0)	6/5
MECHANIZED	6/1	(1/0)	6/2		6/2
TOTAL	16/8		17/9		18/10

Note: Active Components / ARNG Components.
(Change) refers to increases between FY's.

Source: Author.

From Table IV, it can be seen that there would be no anticipated increase in the number of divisions until FY 86, at which time there would be an addition of one active duty infantry division and one ARNG mechanized division . Beyond 1986, there would be slow but continuous growth thru 1990 when two more divisions would be activated. These divisions would include one active duty infantry division and one ARNG armored division.

While the total number of divisions is increasing by only four over the eight year period, the existing divisions would also be undergoing force restructuring to match the on-going equipment modernization program.

The divisions should be "grown" slowly to insure that the army can recruit, train and meet the personnel requirements of the future organizations, and satisfy doctrinal and deployment requirements. Modernization will require many soldiers to be "grown" from within to produce the specialists needed. Because of the present budgeting process, the lead time required to field a properly trained soldier is from 27 to 40 months (from requirement

identification to unit availability) [Ref. 4]. Having established division mix and aggregate manpower requirements, the next step involves determining experience or paygrade requirements.

3. Projected Paygrade Requirements

The experience mix is very important in an organization like the Army, because it is hairarchical (entry level is usually at the bottom). This issue will be discussed in Chapter Three. The development of paygrade requirements is based on the following assumptions by the author:

1. the present manning levels and support ratios remain constant in the type divisions,
2. the present career mix (percentages of the total force within each paygrade) remains constant, and lastly,
3. the 1982 manpower data base is accurate.

If these assumptions are valid, then the projections of Army manpower requirements by paygrade in Table V will be valid.

D. SUMMARY

Based on the previously described division mix and projected growth, the total Army manpower requirements will increase from 1.426 million in FY 1982 to 1.614 million in FY 1990. This equates to an overall growth of 13.2 percent. However, note, as shown in Figure 2.5, that each component (active / reserve) grows at a different rate. The significant point is that under this scenario the Army will be increasing its dependence upon the Army Reserve Components.

TABLE 7

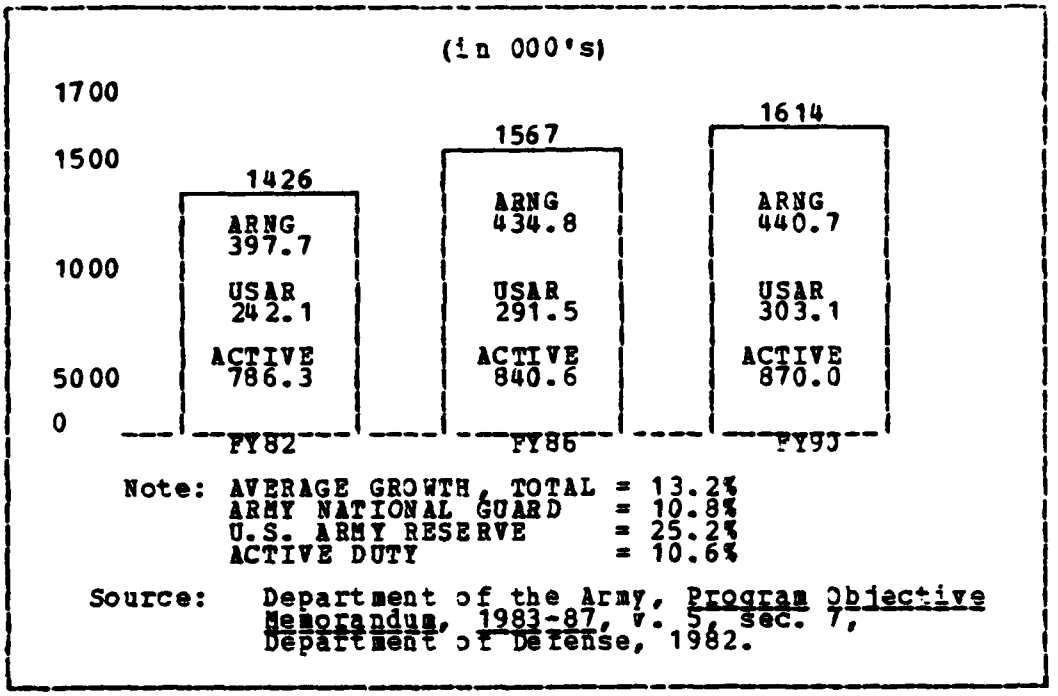
PROJECTED ARMY ENLISTED REQUIREMENTS

(000's)

FY		1982	1986	1990
PAYGRADE	(%)			
E1-E4	(56.7%)	700.4	766.1	788.8
E5	(19.2%)	237.2	259.4	267.1
E6	(13.4%)	165.5	181.1	186.4
E7	(7.9%)	97.6	106.7	109.9
E8	(2.2%)	27.2	29.7	30.6
E9	(.6%)	7.4	8.1	8.3
TOTAL	(100.0%)	1,235.3	1,351.1	1,391.1

Note: Yearly data are available in Appendix F.

Source: Department of Defense, Manpower Requirements Report for FY 1982, February 1981. (Adapted by the Author.)



Note: AVERAGE GROWTH, TOTAL = 13.2%
ARMY NATIONAL GUARD = 10.8%
U.S. ARMY RESERVE = 25.2%
ACTIVE DUTY = 10.6%

Source: Department of the Army, Program Objective Memorandum, 1983-87, v. 5, sec. 7, Department of Defense, 1982.

Figure 2.5 RESERVE COMPONENT GROWTH REQUIREMENTS

III. MANPOWER SUPPLY AND DEMAND ISSUES

"Manning the total force is the major challenge the Army faces today". [Ref. 2]

Whether or not the United States could raise its armed forces by voluntary means has been a controversial issue since military conscription was abolished in 1973 [Ref. 5].

The ability of the AVF to provide the enlisted manpower required to meet U.S. defense objectives for the remainder of this century depends upon essentially three factors:

1. the supply of applicants,
2. the demand for enlisted manpower,
3. the quality standards used in screening the applicants.

This chapter will discuss these issues as they apply to the active force only. The reserves share a number of problems with the active force, but the differences are such that to describe them would be beyond the scope of this paper.

Military employment differs from the civilian counterpart in two important respects: the barriers to entry, and the barriers to exit. The fact that the military obligates new entrants for a period of service via the enlistment contract constitutes a barrier to exit. Conversely, because the military maintains a "closed" personnel system, in that it fills its upper ranks almost solely from within, there are barriers to entry (in the career ranks). This implies that there are two separate groups, first term enlistees and careerists.

Translating this into a simple model of labor supply and demand directs the analysis to the flow of personnel into

the first term enlistment To begin with, the demand for recruits is a downward sloping function of the cost of first-term labor, at least in the long run. As first-termers become more expensive relative to other inputs to the defense mission, fewer first-termers and more of the other inputs will be demanded. This is shown in Figure 3.1.

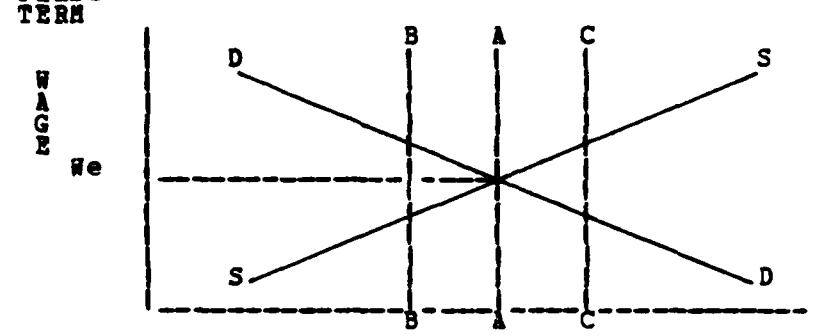
In the short run, recruiting objectives (demand) may be relatively inflexible, since for a given force structure, it may take time to alter the mix of inputs to the defense mission. This is shown by line (AA) in Figure 3.1. At equilibrium, wage (We) is paid, recruiting objectives would be set at point B and the Army would be able to attract a sufficient number of volunteers. At any point in time, there could be factors which would result in recruiting objectives that are less than equilibrium (as shown by line BB) or more (as shown by line CC). To the extent that the recruiting objectives change substantially, care must be taken to identify which observed results correspond with supply behavior and which reflect demand phenomena.

A. MANPOWER SUPPLY ISSUES

1. General Information

From traditional labor supply theory, it is convenient to categorize those factors that are expected to influence individuals to seek military employment into several major groups. These groups are:

1. tangible aspects of military service,
2. dissemination of information to potential recruits,
3. employment and earnings conditions in the civilian economy,
4. the population base from which the military must draw its recruits,



Note: D = demand, S = supply,
We = equilibrium wage.
First Term Military wage refers to the earnings of a soldier within the first three years of a contract.

Source: Rand Note R-1450-ARPA, Military Manpower and the All-Volunteer Force, by R.V.L. Cooper, 1977.

Figure 3.1 ENLISTMENT SUPPLY AND DEMAND (ARMY)

5. individual tastes for military service.

Of the various tangible aspects of military employment, the most obvious factor is military pay. Higher levels of military pay, other things being equal, should induce more individuals to apply for enlistment. But there are other important factors as well, such as the length of the initial enlistment tour, the opportunity to obtain training, and the enlistment options used to lure potential recruits into the military. Such enlistment options can and do include the freedom to specify one or more items (i.e., occupational assignment, type of training, assignment location, etc.) as a condition for entering the military. As

the military offers more options to potential recruits, more individuals will enlist, simply because more will find a match between their own preferences and what the military has to offer.

The second factor concerns Army recruiting activity, which includes recruiters in the field, mailings, advertising, and logistical support for the recruiting establishment. Recruiting may serve merely to inform potential recruits of the employment opportunities in the military and it may also serve to persuade some to join. In any case, a larger or more efficient recruiting effort would be expected to yield more enlistments. Note that, in general, the tangible attributes of military employment and the Army's recruiting efforts can be manipulated through policy directives, either by the service, DOD or Congress.

The third set of factors pertains to the employment and earnings conditions in the civilian labor force. As the earnings opportunities from civilian employment improve, other things being equal, fewer individuals would seek military employment. Alternatively, with higher unemployment, more people would try to enlist. The state of the economy cannot be predicted with certainty but with some abatement in inflation, business and industry would be projected to create more jobs.

The fourth factor is the population base from which the military draws new recruits. A larger population base would be expected to yield more enlistments. The importance of the population base comes from the well known decline in the numbers of young men, a decline that is already taking place.

Figure 3.2 displays the historical and projected number of males (17-21) in each calendar year. The absolute numbers peaked in 1979,and decline steadily thru 1990 to

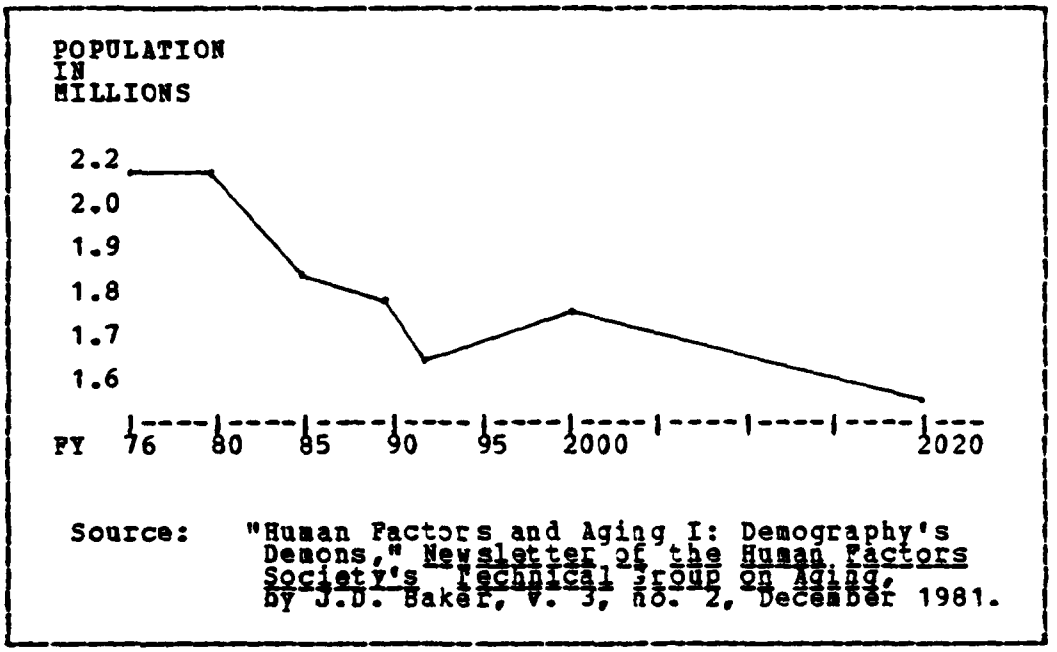
about the same size as the 1970 base. The target population will increase again in 1993, as a result of the second generation World War II "baby boom".

> "For the military, the population decline of the 1980s' should be mitigated somewhat by a corresponding increase in the numbers of high school graduates. Thus, for example, while the 17-21 year old male population is projected to be 11 percent smaller in 1990 than in 1975, the high school graduate, male population is projected to be only four percent smaller". [Ref. 6]

While the trend in the total number of males is on the decrease, other trends individually and in combination compound the projected source pool problem. The total number of males enrolled in institutions of higher education will essentially double over the period from 1965-1986, while the number of 18-21 year old males (U.S.) will increase only 28 percent in the same period. Added to the higher education enrollments is the phenomenal increase in post secondary school vocational and technical education. Between 1965 and 1975, the federally aided vocational and industrial programs tripled. The significance lies in the fact that the majority of males undertaking vocational and technical training will, on completion, enter the civilian job market, few of them having ever been available to military recruiters [Ref. 7].

The last influencing factor concerns the individual's tastes for military employment. The variables included are job content, working conditions, and the like. Some individuals prefer the content and structure of military employment, while others do not. Some of the reasons include:

1. national sentiment toward military service,
2. national security situation,
3. image of the service, as perceived by potential recruits and the people who exert influence on them (such as peers, parents, etc.).



Source: "Human Factors and Aging I: Demography's Demons," Newsletter of the Human Factors Society's Technical Group on Aging, by J.D. Baker, v. 3, no. 2, December 1981.

Figure 3.2 POPULATION DECLINE OF 17-21 YEAR OLD MALES

2. Surveys of Enlistment Intent

There are two primary techniques for examining the roles that the various factors have historically played in the enlistment decision process: surveys and econometric models. Each has its own set of advantages and disadvantages, and, thus, they can be viewed as complementary techniques. Surveys of enlistment intent permit the analyst and policymaker to explore many aspects of the decision process for which other more objective techniques cannot be used. For example, surveys provide the opportunity to assess some of the reasons affecting the taste for military service; an aspect of the enlistment decision which is difficult to include in formal econometric models. At the same time, surveys have a number of well known problems, not the least

of which is the disparity between stated intentions and actual enlistment behavior.

Propensity to enlist has been measured, since 1975, by the Youth Attitude Tracking Study (YATS). YATS conducts periodical surveys of nationwide samples of 16-21 year olds who have not served in the military and who are not beyond their second year of college.

Respondents are asked how likely they are to serve in the military over the next few years, on a four point scale of likelihood: definitely, probably, probably not, and definitely not. Those answering definitely or probably are considered to have positive propensity. The others, including those who do not answer, are considered as members of the negative propensity group. Table VI shows the trends for enlistment propensity.

TABLE VI

NATIONAL TRENDS IN ENLISTMENT PROPENSITY

(in percent)

SERVICE	FALL 75	FALL 78	FALL 80	79-80 DIFF.	75-80 CHANGE
USAF	20.4	15.6	18.6	+3.3	- 9%
USN	19.6	14.4	13.1	-0.3	-33%
USA	18.4	11.8	13.0	+1.2	-29%
USMC	14.9	10.0	10.8	+0.8	-27%

Source: Market facts, Inc., The Public Sector Research Group, Youth Attitude Tracking Study: Fall 1980, March 1981.

The YATS shows that about 30 percent of high school graduates and seniors have a positive military enlistment propensity. However, as is shown in Table VI, the Army is the third choice of the four services. It also shows the Army last in percent share of the critical market segment

(the higher quality, AFQT category I-IIIA graduate). The YATS also shows that the overwhelming preference of high quality (AFQT category I-IIIA) youth is to attend college (73.4%) [Ref. 8].

> "In the volunteer environment, we must rely on the market mechanism not only to regulate the flow between private and military sectors, but to control the flow among the services as well. As long as present conditions exist, the Army will be highly under represented in the much sought after high school diploma graduate category I-IIIa market". [Ref. 9]

3. Quality of the Source Pool

> "Quality, in the Department of Defense lexicon, generally refers to those characteristics and attributes of military personnel that are considered desirable and that contribute to a more productive, capable, and better motivated force. Because of the difficulty in constructing individual profiles to derive measures of motivation and performance and because of the wide range of different occupations in the armed services; manpower quality is customarily described in the shorthand terms of standardized test scores and educational levels". [Ref. 10]

The quality of available youth for military service is a difficult and emotional subject. The aspect of quality under discussion here is the overall intelligence level of the potential source pool. One of the indices of quality mentioned above can be shown to have had a long, consistent and significant decline.

a. Scholastic Aptitude

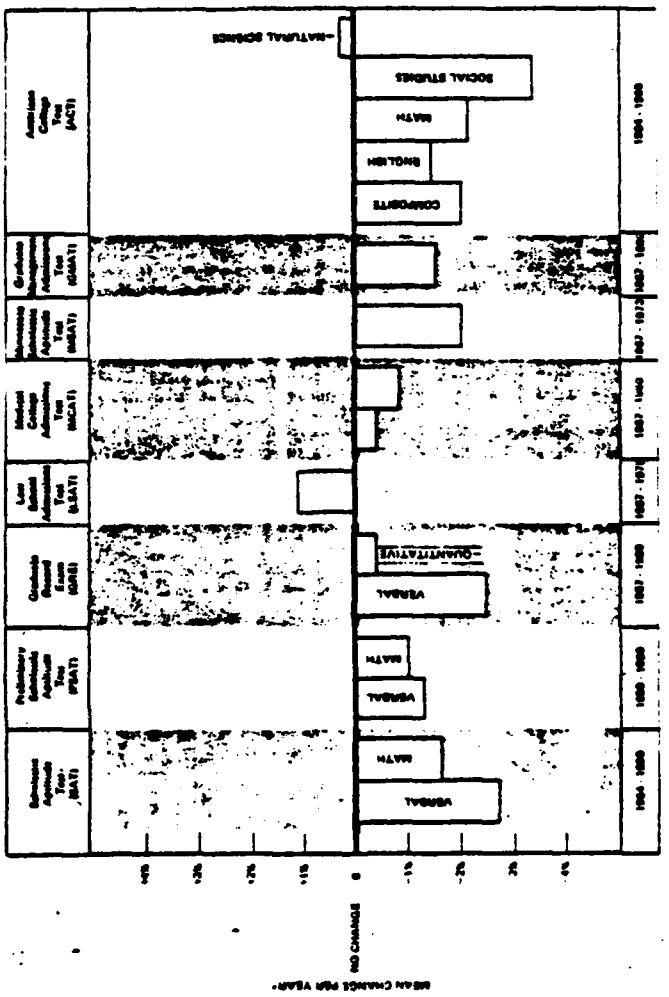
The most clear, consistent and unambiguous evidence of quality decline comes from the results of aptitude testing. Figure 3.3 provides a compilation of the trends in aptitude test data in this country since early in the 1950's. With the exception of the Law School Admissions Test and the National Science subtest of the American College Test (ACT), all of the data show about one to two percent of a standard deviation decline per year since the

mid 1960's. Other major trends show that verbal scores have tended to decrease faster than quantitative scores, and that scores of females have declined more rapidly than those of males, particularly in the verbal domain. Also, overall aptitude test scores increased from 1944 through 1965, but decreased consistently through the late 1970's. This decline continues, although there is some evidence that the rate of decline has lessened somewhat in the past three years. Although the declines are clearly related to a changing population of test takers, the pattern has remained fairly consistent over breakouts by race, ethnic groups, geographical areas, age and socio-economic status. Thus, the causes of the patterns are not clear. The general conclusion is that there are multiple factors which have led to the decline [Ref. 11].

b. Scholastic Achievement

Figure 3.4 depicts the 1964-1980 results for ten achievement test batteries. Data for the batteries have been grouped, when available, into grades 1-4, 5-8, 9-12, and by subtests that roughly parallel the verbal/quantitative/ composites of the aptitude measures. As might be expected, long-term trends across achievement areas are not as consistent as across the aptitude areas.

In general, there is consistent evidence of achievement test score declines, in all areas tested above grade four, for the 1960's through 1970's. Preschool and first thru third grade children scored higher on all measures, with fourth grade students fairly constant. Trends toward lower scholastic achievement are considered to be real, national in scope, and continuing, although at a decreasing rate of decline, since about 1977 [Ref. 11].



Source: Directorate of Accession Policy, Office of the Secretary of Defense, Technical Memorandum 81-2, The Test Score Decline: A Review and Annotated Bibliography, By B.K. Waters, August 1981.

Figure 3.3 MANPOWER SOURCE POOL APTITUDE MEASURES

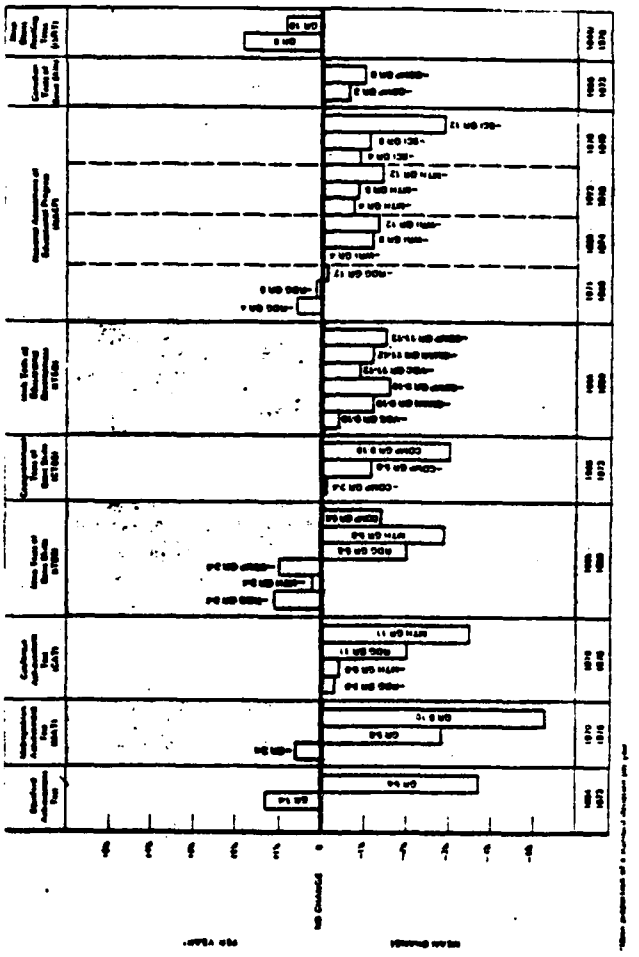
It is evident that national youth performance on scholastic aptitude and achievement tests has been in a state of decline. Assuming comparability of populations, for current military enlistment eligible youth (17-21) the scope of the decline, based upon the literature reviewed, would likely represent a general decrease of approximately two to three percent of a standard deviation per year since 1970.

> "This rate would equate to a decline of about four or five points for the average military enlisted accession from 1971 to 1980". [Ref. 11]

The Armed Forces Vocational Aptitude Battery is used by the military services to determine eligibility for enlistment, and qualifications. for assignment to specific military jobs. Four ASVAB subtests are combined to form the Armed Forces Qualification Test (AFQT), general measure of trainability and a primary criterion of enlistment eligibility.

From FY 1962 through FY 1973, the proportions of new recruits who scored in the various AFQT categories remained fairly constant. An increase in AFQT scores occurred during the period FY 1974 through FY 1976. This rise in test scores was a function of several factors, including the end of the Vietnam War and the consequent drop in the number of accessions required, heightened recruiting efforts in connection with the end of conscription, and an increase in military pay and compensation. In FY 1977, the AFQT scores of recruits dropped sharply. Major factors that contributed to this decline were an improved national economy following the recession of 1974-75, a relative reduction in military pay and benefits, and an error in calibration of the ASVAB.

In 1981, the Profile of American Youth Study, sponsored by the DOD and the military services, in cooperation with the Department of Labor, assessed the vocational



Source: Directorate of Accession Policy, Office of the Secretary of Defense, Technical Memorandum 81-2, The Test Score Decline: A Review and Annotated Bibliography, by B.K. Waters, August 1981.

Figure 3.4 MANPOWER SOURCE POOL ACHIEVEMENT MEASURES

aptitudes of a nationally representative sample of youth to develop current (versus World War II) norms for the DOD enlistment test, the ASVAB.

A comparison of the military accessions with the 1980 youth population showed the following:

1. In general, FY 1981 accessions of both sexes scored higher on the AFQT than did their counterparts in the profile study population. FY 1981 minority recruits scored higher than minorities in the youth population, but this was not the case for white youth;
2. Average AFQT percentile scores were highest for youth in the New England and West North Central Regions of the country, and the lowest in the three southern regions;
3. The average AFQT percentile scores of the 1980 youth population increased with age;
4. The average AFQT scores of males and females were quite similar. However, sex differences in the average test scores were found on the aptitude composites. The females scored lower than the males on all but the administrative test;
5. The proportion of FY 1981 Army accessions in the above-average AFQT categories was 14 percentage points below the comparable proportion in the 1980 youth population;
6. Approximately the same proportion of Army accessions and contemporary youth scored in the below-average categories;
7. The median AFQT score for FY 1981 non-prior service accessions in the Army was 41 as compared tothe DOD average of 52, and the 1980 profile youth median of 51 [Ref. 12].

c. High School Graduates

The personnel presently in active duty armed forces have been described as superior to those of the past in terms of test scores, educational levels, and percentages of high school graduates. However, the use of high school education as a measure of quality is becoming less relevant. As of 1979, all but four states were planning to require students to pass minimum competency examinations for high school graduation.

> "It has become clear that the granting of a high school diploma has become a pr5forma gesture and no longer indicates that the graduate can read or calculate at the twelfth grade level. Neither the diploma nor good grades can be relied on as implying competence and motivation." [Ref. 13]

In a national study, it was found that the reading grade level (RGL) of the average high school graduate dropped from 10.9 in 1960 to 9.5 in 1972. In the near future, New York City is expected to require high school graduates to demonstrate that they can read at the ninth RGL by passing a standardized test. As of 1980, California seniors must meet local standards in reading, and arithmetic before they can get a diploma [Ref. 13].

High school graduation has been considered an index of attitude and motivation, as well as a reasonable academic measure. Obviously, the average high school graduate must still be considered, on average, as being more competent and more motivated than the nongraduate. However, high school graduation today means somewhat less than it did five or ten years ago.

d. Forecasting Accessions

The era of the all volunteer force has generated great interest in forecasting the supply of enlistments that would be available under a variety of conditions. Very

little research had been done in this area during the draft years, and data available on nondraft motivated volunteers were limited to a few months of accessions during the years 1947-48. However, in the late 1960's and early 1970's there were some attempts by DOD to estimate the cost of an all volunteer force.

With the advent of the AVF, the chief concern has been with recruiting the so-called high quality (high school graduate, mental category I-IIIA) non prior service male. Recruitment of females, non-high school graduates, and mental category IV and V personnel has not been supply limited. In general, more people in these groups have volunteered for service than service policy would permit enlisting.

Projections of the supplies of high school graduate, non-prior service, male recruits by service, by mental group, and by year through 1990 have been made by Richard Fernandez of the Rand Corporation [Ref. 14]. The Rand projections are the result of a time series analysis of aggregate data from each service for the entire United States for the years 1970-1978. Using regression analysis, the elasticities of recruit supply to variations in population, pay, unemployment, and numbers of recruiters were calculated, and these elasticities were applied to various conditions that might exist in the future.

The Rand model attempts to measure the effects on enlistment of a declining youth population under varying conditions. The Rand elasticity coefficients produced a negative correlation when forecasts made using previous years' data were compared with 1978 data. This led the analyst to postulate that a structural change not related to the four variables under study may have occurred which caused a decline in enlistments in mental category I and II

recruits. (The end of the GI bill and a reduction in the number of attractive training guarantees in the Army have been suggested as causes.) To accomodate this unknown variable, Rand made two projections for the upper two mental categories. Case A assumes that whatever caused the 1978 fluctuation was temporary, and case B assumes that the change was structural and will not be reversed. The effect on mental category III's was negligible.

Table VII (the ARMY NPS MALE SUPPLY DETERMINATION MODEL) delineates the results found by the author using the Rand (Fernandez) Model. The inputs (elements) were changed as shown in Table VII, to adjust for the changes (i.e., in military / civilian pay ratio, number of recruiters and the unemployment rate) that have taken place since the original study was published (in 1978). Note the sharp decline in the predicted accessions between 1982 and 1986, and the more gradual decline from 1986 thru 1990.

Other uncertainties raised in the Rand report have suggested that cross-sectional (as opposed to time series) analysis would be useful. A cross-sectional analysis uses data from small subdivisions of the country (i.e., states, counties), taken at the same time, and attempts to develop supply elasticities for the variables under study. If the subdivisions are properly chosen, there may be significant variation among them in unemployment rates, population, recruiters and pay scales. This verification would avoid some of the difficulties associated with time series analysis. During the decade of the seventies, there was a very small variation in the population of 17 to 21 year olds in the U.S. as a whole, and real dollar military pay changes varied almost exactly with recruiter force size. Because of this, it is difficult to know which one of two or more variables is producing the change in recruit supply in a time

TABLE VII

ARMY NPS MALE SUPPLY DETERMINATION MODEL

ELEMENTS	FY81	FY82	FY86	FY90
POOL(000's)	2000	1960	1730	1680
MP/CP RATE	39.72	43.15	43.15	43.15
RECRUITERS	5080	5480	5880	5880
UNEMPL. RATE	8.9	8.0	6.9	6.7
YOUTH UN. RATE	19.76	23.17	19.25	18.85

PREDICTED ARMY NPS MALE ACCESSIONS (in 000's)

AFQT TEST	FY81	FY82	FY86	FY90
CATEGORY I&II	23.5	27.8	21.7	20.8
CATEGORY IIIa	15.9	16.9	15.7	15.2
CATEGORY IIIb	28.1	33.6	26.2	25.0
TOTAL	67.5	78.3	63.6	61.0

Notes: POOL: NPS male civilians aged 17-21.
MP: average first year regular military compensation for enlistees with less than two years of service.
CP: average weekly earnings in the total private economy, seasonally adjusted.
RECRUITERS: number of production recruiters.
UNEMPL. RATE: national unemployment rate.
YOUTH UN. RATE: unemployment rate for males, aged 16-19, seasonally adjusted.

Source: Rand Model adapted by the Author.

series analysis. By taking small subdivisions, the cross-sectional analyst can obtain a large enough data base without using the pre-1973 data that may have introduced further uncertainty in the Rand time series analysis.

Studies by the Center for Naval Analysis (CNA) and Duke University have taken this cross-sectional approach and obtained results different from those of Rand. The Rand and CNA projections are not exactly comparable because of different assumptions about the economy. But the Rand "high growth" projections are compared in Table VIII with the CNA "less vigorous" projections as the two most compatible scenarios in the studies. The cross-sectional study done at

Duke University also produced results more optimistic than the Rand projections.

TABLE VIII

CNA AND RAND FORECAST COMPARISONS

(NAVY NPS ENLISTMENTS BY MALE HIGH SCHOOL DIPLOMA GRADUATES IN MENTAL GROUPS I-III, FY 1980-84)

	CNA		RAND	
FY	Forecast/	Difference	Forecast/	Difference
1979	50723	0	50723	0
1980	54303	+3580	46315	-4408
1981	52301	-2002	48913	+2598
1982	50076	-2225	48995	+ 82
1983	48240	-1836	46946	-2049
1984	46215	-2025	43774	-3172

Notes: (1) In FY 1979 the actual number of NPS enlistments by male high school diploma graduates in mental groups I-III was 50723.
(2) Rand uses the Moderate unemployment scenario.
(3) Forecast Difference =s last years strength minus this years strength, (i.e., 50723 - 54303 = +3580; 1979 - 1980 CNA Forecasts).

Source: Department of Defense and Navy Personnel Supply Models, Proceedings from a Workshop held at Arlington, Va., January 22-23, 1981.

As striking as the projection differences are, the divergence in the results of the independent studies can best be illustrated by examining the coefficients of elasticity, from which can be seen very different conclusions, (see Table IX). The Rand study finds very low supply elasticity with respect to recruiter strength, while the Duke and CNA studies show this factor to have a very significant impact. The Rand study finds supply most elastic with respect to unemployment, but the other studies find low elasticities with respect to this factor. Elasticity with respect to pay varies significantly among the studies. The studies are in agreement concerning two conclusions:

1. the supply of male NPS high school graduates in mental categories I-III will decrease during this decade under all economic conditions examined,
2. the supply decrease will be proportionately greater for mental groups I and II than for IIIA and IIIB under all economic conditions examined [Ref. 7].

TABLE IX

ELASTICITY COMPARISONS OF ACCESSION FORECASTS

(AFQT Test Category I-IIIA, Male, High School Graduates)

ELEMENTS /	RAND I&II/IIIA	CNA	DUKE
RMC (pay)	.8835/.5447	-1.08	.0254
UNEMPLOYMENT (youth)	.245/-.0493	.36	.1792
RECRUITERS	.0733/.3752	.48	.2406

Notes: (1) Rand data are for case B only.
(2) Rand data are divided into AFQT categories.
(3) Elasticity is the percentage change in supply given a one percent change in a supply factor.

Source: Department of Defense and Navy Supply Models, proceedings of a Workshop held at Arlington, Va., January 22-23, 1981.

None of the afore-mentioned studies accomodate such variables as youth attitudes, political climate or educational opportunity. Each of the models has deficiencies. They also differ conceptually in what they attempt to forecast, and their data bases are not compatible with one another. Perhaps most importantly, analyses using ASVAB data comparisons over the 1976-1980 time frame suffer from its misnorming problems. Due to the reasons above, the forecast results are considered "soft", in their predictive capabilities.

e. Supply Summary

Within this section, it has been shown that the source pool is declining in total numbers and that the mean aptitude and scholastic test abilities are also decreasing. The Youth Attitude Tracking Study results show that approximately 30% of the sample indicated a propensity to enlist. However, it also showed the Army to be their third choice. Of those that are enlisting, the Profile of American Youth Study show that the Army is getting the lowest AFQT test quality personnel. The median AFQT score was 41 as compared to the DOD average of 52 and the Profile Youth sample median of 51. Forecasts of AFQT test catagory I-IIIA accessions show a continuous decrease over the period 1982 through 1990. Enlisting more women and males of less educational attainment, using labor-saving devices, or substituting civilians for military jobs, may have to occur in order for the military to maintain its present quality standards and size. This may be a result of both a decrease in the quantity and quality of the supply pool and of expected future competition from industry for the 17-21 year old cohort. In an effort to attract more of the target group, the Army may have to offer a more competitive wage, renew its educational benefits, and enhance its publicity program to improve its public image.

B. DEMAND ISSUES

1. General Information

In the absence of a relatively guaranteed supply of manpower, as provided by the draft, the demand for enlistments has become one of the most crucial aspects of defense manpower planning and management. The importance of enlistment demand to any assessment of the volunteer force is

illustrated in Figure 3.1. It shows that, the feasibility of the volunteer forces involves both the supply of manpower to the military and annual accession requirements (demand).

Initially, the major question that the President's Commission on the All Volunteer Armed Force (GATES Commission) had to resolve was: What pay rate would be required to equate accession supply and demand? Once the general pay rate was set, as it was with the first-term pay raise in 1971, the feasibility issue became one of determining supply and demand in the future. In other words, whether the AVF presents a viable alternative for sustaining the U.S. defense commitments depends on whether enlistment demand is rationally determined, as well as on whether sufficient supply is forthcoming.

2. Sources of Enlistment Demand

It is common to view the demand for enlisted accessions as an objective, or goal, in its own right, and this is correct in the case of the middle manager charged with recruiting a specified number of new people. Yet, from the broader viewpoint of overall force management, the demand for enlisted accessions is but a means for attaining the more fundamental objective of force strength goals. In other words, the flow demand is the vehicle for realizing the desired stock demand, the demand for enlisted accessions must be examined in the larger context of force strength objectives.

The policy question , therefore, centers on determining the appropriate level of enlistment demand to achieve force capability objectives. The optimal accession policy will depend on a variety of factors, including changes in force strengths, the particular mission objectives, the value of experience on the job, and the cost of training new

recruits. Ultimately, a cost-benefit analysis must be used to judge the desirability of accessing new recruits as opposed to using alternative sources in order to achieve force capability objectives.

The following simple model shows that the end strength (ES) in year (t) is equal to the previous years' end strength, plus the enlisted accessions (A) occurring during the year, minus the years losses (L) from the force, plus any reserve call-ups (RA), and minus any reserve deactivations (RD).

$$ES(t) = ES(t-1) + A(t) - L(t) + RA(t) - RD(t).$$

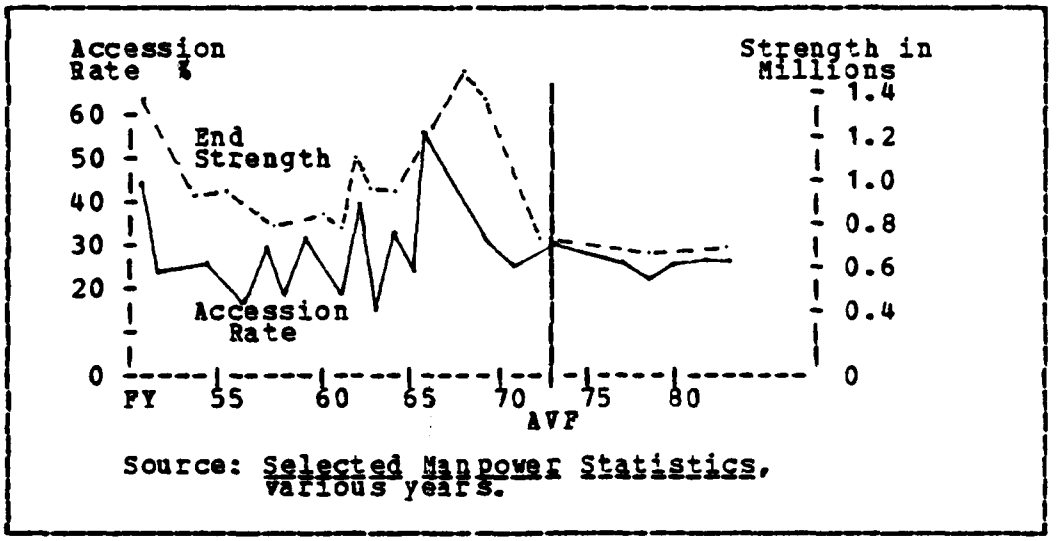
By rearranging the above equation, the force may also be viewed in terms of accessions.

$$A(t) = ES(t) - ES(t-1) + L(t) - RA(t) - RD(t)$$

[Ref. 6].

Enlisted accession goals can be derived from the change in end strengths, plus whatever losses occur during the year (including the attrition from that years accessions), plus the net reserve activations (reserve activations minus reserve deactivations). In other words, accession policies are, in large part, driven by policies concerning to the number of losses from the force.

It should be recognized that losses from the force will, other things being equal, vary with force size. In other words, larger forces will in general yield larger numerical losses. So, viewing the accessions in terms of numerical rates, rather than requirements, will normalize for the variations in force size.



Source: Selected Manpower Statistics, various years.

Figure 3.5 ARMY ACCESSION RATE AND END STRENGTH TRENDS

3. Modeling Enlistment Demand

As discussed earlier, one method of evaluating service accession policy is to conduct a cost-benefit analysis on the desired distribution of personnel by length of service, which, in turn, implies the accession rates required to support the desired force structure. An alternative approach is to structure a statistical model of the demand for enlisted accessions based on past service accession policies.

Using historical data from the years 1955 thru 1972, the Rand Corporation made a study (using regression analysis) to explain past accession behavior. From the viewpoint of the AVF, the results imply that the long-run accession rates (or equivalently, labor turnover rates) should be about 18.5 percent for the Army [Ref. 6].

Assuming accession rates vary on a one for one basis with loss rates, the key to developing a model of accession

demand is in projecting the losses from the enlisted ranks. Given the structure of the military career, it is useful to separate enlisted losses into two groups, those who are in their first term and those in the career force (four or more years of service). Losses from the first term force can generally be thought of as those related to attrition during the first term, and those who do not (or are not permitted to) reenlist. Career losses, on the other hand, consist primarily of non-reenlistees and retirees.

Because of its magnitude relative to losses, the key variable for planning purposes is the number of reenlistees from the first term. This, in turn, is dependent on the size of the cohort eligible to separate from the military and the percentage of those who reenlist (i.e., the reup rate). In general, though, variations in cohort sizes, rather than reenlistment rates, are likely to be the dominant factor when predicting loss rates.

4. Career Mix

a. General Information

The closed nature of the military personnel system means that the military draws its experienced personnel from within the system. Therefore, to maintain an adequate stock of experienced personnel, the Army must also maintain an adequate stock of junior personnel.

Because of the "up-or-out" nature of military promotion policy and the strong association between promotion opportunities and length of service, promotion policy has played a key role in determining the experience mix of the service. The Army has been reluctant to have too many junior personnel, lest there be a glut of personnel eligible for promotion to the higher grades (with a corresponding reduction in promotion opportunities). But they have also

been reluctant to have too few junior personnel, lest there be inadequate selection opportunities. Manpower requirements should, of course, be the primary determinants of the number of junior personnel.

As a result of these concerns, the Army has devoted considerable effort to the development of management policies for assuring the "proper" experience mix of the force. However, because factors such as the maintenance of adequate promotion opportunities for military personnel have been a point of emphasis, decisions regarding the experience mix of the force have frequently been based more on personnel management concerns than upon requirements or cost issues.

With the advent of the AVF, the issue of the experience mix assumed a new and somewhat different importance, although the basic problem remained the same (choosing the appropriate mix). The removal of the draft made the experience mix as much a resource allocation (or requirements) issue as a personnel management issue. By underpricing junior personnel, the draft encouraged the Army to develop and maintain a manpower utilization pattern that emphasized the use of junior personnel, especially enlisted. The removal of the draft in 1973 and the concurrent large AVF pay raises for junior personnel, argue for reexamination of the experience mix. Therefore, determination of what the Army enlisted accessions requirements should be requires consideration of costs and productivities.

b. Cost Issues

The inherent problems of screening large numbers of personnel, as well as the constraints and pressures of supply and demand, insure that the mix will be less than perfect. In practice, experience is used as a proxy measure

of an individual's potential for adequate performance at the next higher pay grade. In addition, promotion policies are influenced by fiscal constraints, and by vacancies at the next higher paygrade. Promotion also serves as an important retention tool, because it affects expected military pay. For these reasons, the relationship between paygrade and ability will vary over time.

The experience level of the force provides a second measure of quality. It can be measured several ways:

1. by the average years of service of personnel on active duty,
2. by the average years of service of career personnel (those with more than four years of service),
3. or as the entire experience distribution of the force.

Within limits, one can reasonably expect that more experienced personnel will be more productive and have greater leadership ability than do less experienced personnel. If there is a large enough supply of potential enlistees the screening process with each reenlistment point (and promotion point) can serve to eliminate less productive personnel from the force.

The paygrade distribution within the Army is highly correlated with the experience distribution. However, the experience distribution of the force is somewhat less subject to the types of policy changes that can obscure the meaning of paygrade as an indication of ability, at least over short periods. Paygrade is a discontinuous measure in that, for example, a soldier can arise in the morning as an E-4, but retire that evening as an E-5. In contrast, the soldier has gained only one additional day of experience.

There is one obvious but important point to remember when discussing career mix. Personnel in higher paygrades and of greater experience are more costly than personnel in lower paygrades and of lesser experience. Basic pay rises with both paygrade and tenure, and allowances rise with paygrade (i.e., housing). Retirement costs, also, are a significant deferred cost of a more career intensive force. Therefore, a more career intensive force, with more non-commissioned officers, must be one that results in lower accession and training costs, and greater productivity or effectiveness, if it is worth the higher price.

c. Military Productivity

Productivity in the private sector can be measured in terms of units produced and sold, and effectiveness can be assessed by the profit standard. But in peacetime, military output is vaguely defined and is related to preparedness, which cannot be accurately measured.

Cooper, in his Rand Corporation sponsored study entitled, "Military Manpower and the All-Volunteer Force", states:

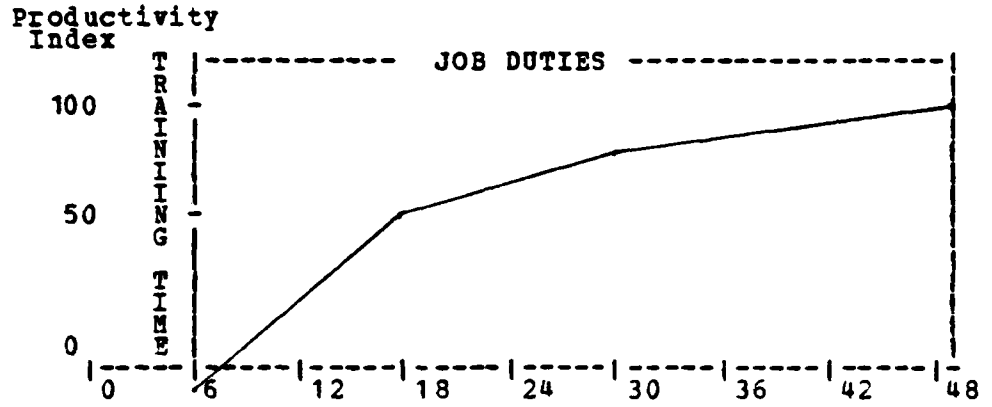
1. the average basic pay for first termers has increased relative to that of careerists, but that careerist base pay is more than first-termer base pay in the absolute sense,
2. careerists are more productive on the job,
3. and lastly, there are non-basic pay personnel costs that impact more heavily on first termers than careerists.

In particular, the substantial attrition of first termers make career personnel more cost effective.

That is, the nature of the timing of personnel costs, productivity on the job, and first-term enlisted attrition all serve to make career personnel more cost effective; so, the substitution of careerists for first-termers can decrease costs and/or increase overall force capability.

The results of another Rand study indicated a substantial difference between the productivity of experienced personnel and that of very inexperienced first-term personnel. For example, the average individual with 18 months of service was estimated to be only one- half as productive as the average individual with four years of military service (assuming that six months was spent in training and transit). In fact, during the first few months on the job, individuals are estimated to have negative productivity, in the sense that the amount of supervisory time that they require exceeds their own productive contribution. Overall, the Rand estimates show that individuals during the entirety of their first four years of military service are on the average about 55 percent as productive as the typical serviceman with four years of service, (see Figure 3.6) [Ref. 15].

This means that careerists can be substituted for first-termers on less than a one-for-one basis without decreasing military capability. For example, the Rand estimates imply that for every 100 individuals with four years of service that are added to the force, about 180 first-termers could be removed without reducing the capability of the force. However, it should be remembered that this is an assumption bounded by marginality in that there is a point where this statement would no longer hold true.



Note: 100 = typical four-year serviceman.

Source: Unpublished tabulations provided by Robert M. Gay, Rand, 1976.

Figure 3.6 PRODUCTIVITY OF FIRST TERM ENLISTED PERSONNEL

d. Summary

The reason that accession requirements have failed to adjust downward is in fact largely a result of the Army's insistence on maintaining a very junior enlisted force. Although the issue of enlisted accession demand has been recognized, demand reduction programs have been most commonly viewed in terms of such policies as: accessing larger numbers of women and substituting civilians for military billets, thereby reducing the demand for NPS male accessions. The practical implications of these findings are substantial. For example, the Gates Commission estimated that a force of 2.089 million enlisted could be sustained with an annual enlisted labor turnover rate of 15.8 percent. If, as Cooper states, the accession demand of 24.1 percent

experienced during the AVF transition were to prevail, then the maximum enlisted force that could be sustained without the draft would be on the order of 1.4 million or less. In other words, the viability of the AVF may be much more a function of how well the Army adjusts their demand for enlisted accessions than of enlistment supply [Ref. 6].

5. Skill Drain

a. General Information

Retention efforts for the total Army encompass both attrition management and reenlistment/extension programs. The primary goal is the achievement and maintenance of an experienced career force in each component, composed of skilled soldiers in the right numbers, skills, and grades to meet peacetime and mobilization requirements [Ref. 16].

b. Attrition

The relationships between attrition and readily available indicators of propensity for attrition have been extensively studied by all services and the General Accounting Office. Some of the best predictors found are level of education, age, mental category and reading grade level.

The nearly 40 percent attrition (separation of a soldier prior to completion of a contracted term of service) of the Army's first All Volunteer cohort represents an enormous cost. The U.S. Comptroller General has estimated that attrition from the services between FY 1974 thru 1977 cost $5.2 billion, in terms of direct costs to the services and veteran's unemployment compensation and benefits [Ref. 17]. Attrition of service members who are unsuitable is good. What is bad, is that enlistment standards allowed a

large number of unsuitable individuals to enlist. High attrition is costly and requires more recruits than would otherwise be necessary to sustain a given force size.

Attrition has been shown to be highly correlated to social adjustment of an individual. The best single measure of social adjustment readily available to the Army is the high school diploma. Although the correlation between high school attendance and scholastic achievement has declined over the last 20 years, graduates have been shown to be more likely to sucessfully complete a contracted term of service. In fact, a person who did not graduate from high school is twice as likely, ceterus parabus, than a high school graduate to leave the military before completing the first three years of service. Consequently, recruiting programs have traditionally emphasized efforts to enlist high school diploma graduates. The percentages by service of NPS accessions over the last decade who had high school diplomas when they entered are shown in Table X.

In FY 1981, the proportion of high school diploma graduates increased significantly in the Army. The DOD total of 81 percent represents an all time high in the educational level of recruits. These results reflect vigorous recruiting efforts, additional recruiting resources provided by Congress, increased military pay and compensation, and higher youth unemployment [Ref. 12].

Attrition losses for the 1977 active duty cohort (those people who entered the Army in same year) are shown in Table XI. The table lists the data by age, sex and education.

From Table XI it can be seen that, non-high school graduate soldiers who entered when they were 17 years old had the highest attrition rate, and those that entered at 20 the lowest. The 17 and 18 year olds with high school

TABLE X

HSD GRADUATE NPS ACCESSIONS (FY 1973-1981)

(in percent)

FY	1973	1974	1975	1976	1977	1978	1979	1980	1981
SERVICE									
ARMY	62	50	58	59	59	74	64	54	80
NAVY	65	64	71	77	73	77	77	75	76
MARINES	51	50	53	62	70	75	75	78	80
AIR FORCE	82	92	91	89	88	85	83	83	88
DOD	66	61	66	69	69	77	73	68	81

Note: Table data include male and female acessions.
HSD = High School Degree Graduates
NPS = Non-Prior Service
DOD = Department of Defense

Source: Office of the Secretary of Defense, Manpower, Reserve Affairs & Logistics, 1982.

diplomas had substantially lower attrition rates than older cohorts. Also notice the difference in the attrition rates between the male and female cohorts. This difference is expected to increase in the future because the Army began to access NHSG females in 1980.

Literacy levels have also been shown to be highly correlated with attrition. For example, a 1976 study on remedial reading programs in the Navy, found the reading grade level (RGL) to be the single best predictor of attrition during recruit training [Ref. 18]. Table XII shows the attrition of Navy men within RGL categories from June 1974 thru January 1975, at the San Diego Recruit Training Center.

A National Defense University survey of entrance qualifications for 288 Army Military Occupational Specialities (MOS), revealed that only four (1.4%) required a high school diploma [Ref. 7]. The survey also indicated that at the execution level (recruiting), qualification

TABLE XI

ARMY COHORT ATTRITION LOSSES (FY 1977-1980)

by sex, age and education, in percent.

MALE

AGE/ EDUCATION	17	18	19	20	21	22+	TOTAL
7&8	60.0	66.7	71.4	40.0	71.4	66.7	68.7
9	58.8	55.7	55.0	54.8	48.5	57.2	55.6
10	50.9	50.0	49.4	49.4	52.9	50.9	50.6
11	47.5	42.2	41.9	41.1	45.6	44.8	43.9
12	39.5	34.4	29.5	26.5	30.2	26.8	33.6
NHS	51.5	46.5	45.8	45.5	48.8	48.5	48.6
GED	52.5	45.9	43.1	44.1	37.3	41.5	43.9
HS	22.5	22.0	24.7	27.5	28.7	29.4	25.2
SOME COLLEGE	34.6	27.5	18.8	21.0	23.1	25.2	25.3
COLLEGE	20.0	15.4	36.4	17.6	33.9	29.6	34.3
HS+	22.6	22.1	24.5	26.7	27.8	28.6	25.4
TOTAL	45.0	31.2	31.4	32.7	34.0	34.3	35.2

FEMALE

Age/ EDUCATION	17	18	19	20	21	22+	TOTAL
7&8	--	50.0	--	--	--	--	50.0
9	--	--	--	--	--	--	66.7
10	64.7	77.8	66.7	50.0	66.7	75.0	70.0
11	50.0	42.6	44.9	70.0	33.3	40.0	45.1
12	16.7	51.6	45.5	28.6	33.3	--	40.8
NHS	52.9	45.5	47.1	52.6	46.2	50.0	47.8
GED	69.8	62.3	59.1	63.8	63.8	59.8	60.0
HS	40.8	39.5	44.2	43.0	44.0	44.0	42.2
SOME COLLEGE	33.3	37.7	38.5	34.7	36.7	39.9	37.4
COLLEGE	--	--	20.0	20.0	27.3	30.0	30.4
HS+	40.7	39.5	43.7	41.4	42.0	41.5	41.1
TOTAL	46.7	41.5	45.3	43.8	44.8	43.6	43.2

Note: Table data is for all FY 1977 acessions.

Source: US Department of the Army, DAPE-MBM, 1981.

standards other than HSD and mental category standards are being applied for specific jobs. So, presuming that only the applicants with the requisite qualifications were accepted, then it can be contended that the Army enlisted the quality of person it felt was needed in those jobs. However, since the result was a trend toward more scores in the lower test

TABLE XII

RELATIONSHIP BETWEEN RGL AND ATTRITION

READING GRADE LEVEL	PERCENT DISCHARGED
Less than 4.0	64.1
4.0 to 5.9	20.4
6.0 to 7.9	10.3
8.0 to 9.9	7.2
10.0 to 12.0	4.2

Source: Air War College
Professional Study Report No.6118,
Remedial Reading Programs for Personnel
Entering the United States Navy,
by J. Zierdt, April 1976.

categories, it can be further argued that the lowered test category trend had little to do with the actual needs, at least in the MOS's considered, because real training problems with the quality of enlistments are being reported [Ref. 18].

The Army has reported the high attrition levels listed in Table XIV. These data are from some of the Army's Military Occupational Skill (MOS) producing schools. It would seem from the high attrition levels that the Armed Forces Vocational Aptitude Battery (ASVAB) was a poor predictor (for these schools) of school performance (i.e., general trainability in the MOS, unadjusted for variables such as training methods, course length, motivation, etc.). The figures also indicate that the MOS qualification standards applied in practice may have also been unsatisfactory.

In another TRADOC survey of an MOS producing school, the percentage of attrition by category (reasons) was investigated. The results were:

1. 37 percent of the failures from the 19D MOS producing course were discharged from the course under the TDP (Trainee Discharge Program),

TABLE XIII

MALE NPS ACCESSIONS BY AFQT TEST CATEGORY (FY 1952-81)

(IN PERCENT).

AFQT TEST CATEGORY/ FY	I	II	III	IV
1952	6.9	20.4	28.7	44.1
1962	5.8	27.3	44.5	22.4
1972	4.0	28.4	48.8	18.8
1976	3.2	25.7	54.5	16.6
1980	1.5	13.7	34.7	50.1
1981	2.2	21.4	44.5	30.9

Note: FY's 1976-80 reflect renormed data.

Source: Data for 1952-1975 are from the Office of the Assistant Secretary of Defense, Manpower Reserve Affairs & Logistics. Data for 1976-80 provided by the Defense Manpower Data Center.

2. another 22 percent were dropped from the rolls for AWOL (Away Without Official Leave) or desertion,
3. 9 percent were discharged for medical reasons,
4. 14 percent were discharged for various hardship or miscellaneous reasons,
5. 15 percent were recycled (not lost, but required extended training time),
6. and 3 percent were retrainees from another MOS.

A combined 59 percent of the failures (TDP and dropped from the rolls) could possibly be related to motivational reasons rather than reasons of ability. In other words, lack of motivation may have been the cause of 22 percent of the total losses from the schools in 1979 (TDP=14%, AWOL=8%) [Ref. 7].

The Trainee and Expeditious Discharge Programs were developed by the services to control the extent and/or

TABLE XIV

ARMY ATTRITION FROM MOS PRODUCING COURSES

JOB DESCRIPTION	MOS/T	RATE% SCHOOL/MISC.
Electronic Warfare (Identify/Locate)	05D/(t)	35
Signal Security Specialist	05G/(t)	30
Electronic Warfare (Intercept)	05H/(t)	38
Cannon Fire Direction Specialist	13E/(t)	26
M1 Abrams Armor Crewman	19K/(st)	25
Missile Repair Specialist	27B/(t)	21
Tow/Dragon Repairer	27E/(t)	29 +(15)
Vulcan Repairer	27F/(t)	34
Chaparral/ Redeye Specialist	27G/(t)	28
Field Radio Repair	31E/(ht)	42 +(14)
Secure Communications Eqpt. Rep.	31S/(ht)	31 +(11)
Field Artillery Computer Repairer	34y/(t)	48 +(11)
M1 Abrams Turret Mechanic	45E/(t)	22 +(11)
Track Vehicle Mechanic	63Y/(ht)	20
Electric Warfare Analyst	98C/(ht)	28

Note: (1) The letters st/t/ht relate to the authors technical categorization of Army MOS's by AFQT; (st) semi technical (75-90); (t) technical (91-99) and (ht) highly technical (100+). More information on the procedure is in Appendix B.
(2) T = technical qualification rating by author.
(3) SCHOOL = school attrition.
(4) MISC. = miscellaneous attrition.

Source: U.S. Army Soldier Support Center, National Capital Region, Supportability Assessment of the Heavy Division 86 Transition, V. I, 1982.

the timing of attrition. These programs are used as "screening devices" to allow unit commanders to discharge marginal performers. The numbers of trainees released via these programs (TDP/EDP) provide an index of the overall effectiveness of the force. Table XV portrays the trends of these programs over the last seven years as decreasing.

First-term attrition rates are expected to decrease from 40 percent to the low 30's thru 1983, when they are predicted to rise again as a result of the high number of NHSDG accessions in 1980. However, the subsequent years should benefit from the high number of high school

TABLE XV

ARMY TRAINEE DISCHARGE PROGRAM RESULTS (EDP/TDP) FY 74-80.

FY	74	76	78	79	80
TRAINEE	13612	21876	9523	8563	11701
EXPEDITIOUS	2565	20888	12563	11292	10097
PERCENTAGE OF TOTAL ACCESSIONS	8.22%	22.23%	16.92%	14.11%	12.66%
TOTAL	16177	42764	22186	19855	21798

Source: Prepared statement of LT. GEN. R.G. Yerks, Deputy Chief of Staff Personnel at a Hearing of the Senate Armed Services Comm. 1981. Percentage of Total Accessions data were obtained from the Defense Manpower Data Center.

graduates accessed in 1981, as well as from the renormed ASVAB and the introduction of cohesion and stability initiatives, such as the planned regimental system [Ref. 14].

c. Retention and Reenlistment

One of the ways the Army achieves its personnel goals is to pursue a very active and attractive reenlistment program. The retention of an experienced work force has the obvious advantage of saving recruitment and training costs associated with enlistments. Moreover, reenlistees should be more productive on the job than a force dominated by more recent accessions. On the other hand, the retention of a disproportionate (beyond marginal efficiency) number of experienced workers means that the average age of the military force increases and the costs of salaries and future retirement benefits rise.

The reenlistment program is designed to retain sufficient highly qualified personnel to meet requirements for an "over four" (years of service) enlisted force of

290,000 plus, and a "top five" (paygrades, E5-E9) content of 274,000 through FY 84. Beyond that point, the career force and "top five" will increase to meet the needs of the expanding force structure. Reenlistment resources, policies, options and incentives, such as the selective reenlistment bonus (SRB), are specifically targeted to encourage reenlistments in critical skills in order to eliminate shortages and meet increasing demand for skilled, experienced, technical personnel to support force modernization [Ref. 14].

The loss of experienced personnel in the middle and late 1970's was one of the most significant manning problems during that period. The loss of experienced personnel from the career force is attributed to a drop in the career reenlistment rate over the last half of the 1970's. The 66.4 percent rate in FY 1979 is generally recognized as the worst career retention year in recent history (see Table XVI). However, 1980 retention increased to 69.3 percent, and in 1981 retention was projected to reach 71 percent.

Many models and surveys have been designed in an effort to find what tastes, preferences and attitudes cause a soldier to reenlist. A study with a large data base and established credibility is the National Longitudinal Survey of Youth Labor Market Experience (NLS). The results of analyses of data from the NLS suggest the following regarding reenlistment propensity:

1. reenlistment intention rates are positively associated with job satisfaction and inversely related to the number of months served in the armed forces,
2. reenlistment intention rates are positively related to educational expectations, but there is no evidence of an association among male enlistees between propensity to reenlist and years of school completed,

TABLE XVI

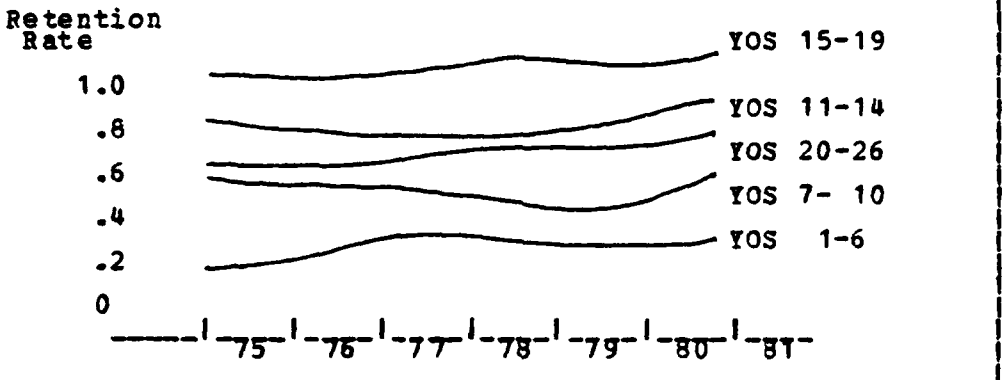
CAREER REENLISTMENT RATES

FY/ SERVICE	1973	1975	1979
Army	63 %	75.4%	66.4%
Navy	91.7%	80.5%	62.4%
Air Force	92.7%	89.6%	81.5%
Marines	81.7%	73.1%	51.9%

Source: Department of Defense, Memorandum for the Members of the Interagency Working Group, Assistant Secretary of Defense, Manpower, Reserve Affairs & Logistics, 30 December 1981.

3. there was a negative association between the education of the parent and the reenlistment intention of the enlistee,
4. married male enlistees report a higher propensity to reenlist than than never married enlistees, but the relationship is reversed among females [Ref. 19].

The career reenlistment rate is simply a weighted average of the reenlistment rate at the second, third,(etc), terms of service, where the "weights" are the proportions of the total numbers making a reenlistment decision that year. Figure 3.7 shows the trends in the retention rates over time for those making reenlistment decisions, (i.e., those who are at an expiration of a term of service point, within various years of service intervals). The trends reveal a relatively modest decline in second and third term retention rates from FY 1975 to FY 1979 (years of service 7-10 and 11-14, respectively). Reenlistment rates at higher terms of service remained constant, or actually increased over the period.



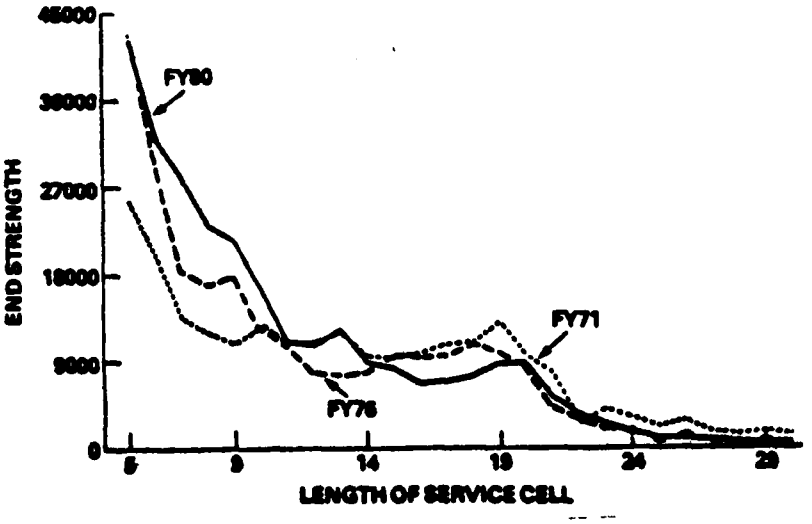
Note: YOS = Years of Service

Source: Department of Defense, Memorandum for the Members of the Interagency Working Group, Assistant Secretary of Defense, Manpower, Reserve Affairs & Logistics, 30 December 1981.

Figure 3.7 ARMY ETS RETENTION RATE TRENDS (FY 1975-1981)

However, what did change radically over the period (1975-81) was the proportion of the career force making reenlistment decisions at the second and third term points relative to those making decisions at higher terms of service. A much larger portion of those making reenlistment decisions in FY 1975 (and 1971) were in years of service 14 thru 20 than was the case in FY 1979. Similarly, the proportion of the career force making enlistment decisions at the second and third term reenlistment points in FY 1979 was greater than the proportion of the career force in the second and third term, who made the enlistment decision in FY 1975 (and 1971). Hence, the decline in the career reenlistment rate over the period was largely the result of

shifts in the number of personnel making reenlistment decisions away from years of service 14 thru 20, where reenlistment rates are naturally high due to the draw of the retirement system, and toward years of service seven thru ten and eleven thru fourteen, where reenlistment rates are lower.



Source: Department of Defense, Memorandum for the Members of the Interagency Working Group, Assistant Secretary of Defense, Manpower, Reserve Affairs & Logistics, 30 December 1981.

Figure 3.8 ARMY CAREER FORCE TRENDS

In short, the decline in the experience level of the career force over the last ten years is only partially explained by a decline in actual retention rates. Rather, it is mostly a matter of the dynamics of the enlisted force. The large cohorts who entered during the Korean War were followed by some relatively small cohorts as accessions were

reduced in order to achieve lower strength levels. The Korean War cohorts represented a large proportion of the career force, but were concentrated in a small number of years of service cells. When these cohorts reached retirement eligibility, a large amount of experience was lost in a relatively short time.

It will take time to restore the experience distribution of the enlisted force to the desired level. Improved retention rates can certainly expedite the process, while a decline would make the process much more difficult. The experience distribution could be restored to the desired levels as the cohorts with between five and ten years of service move into their tenth thru twentieth years of service. Table XVII shows that the first-term reenlistment rate is increasing. This trend must continue if the experience distribution is to get "well" in the future.

TABLE XVII

FIRST TERM REENLISTMENT RATES

(As A Percent of Eligibles)

Service	FY 73	FY 75	FY 79	FY 80	FY 81
Army	38	39	43	51	55
Navy	23	40	37	37	42
Marines	13	20	20	23	27
Air Force	20	40	38	36	43

Source: Department of Defense, Memorandum for the Members of the Interagency Working Group, Assistant Secretary of Defense, Manpower, Reserve Affairs & Logistics, 30 December 1981.

Career reenlistment rates, and, in particular, reenlistment rates at the second and third term of service rose dramatically in FY 1981, reversing the trend of the late 1970's. First term reenlistment rates reached historical proportions in 1981 for each of the services. The combination of the high first term reenlistment rates and improved career retention rates suggests that the experience distribution will improve significantly thru the 1980's. Table XVIII compares the Army's career force projections for 1987 with the actual FY 1981 career force.

TABLE XVIII

ARMY CAREER FORCE PROJECTIONS (FY 1987)

FY	(ACTUAL) 1981	(PROJECTION) 1987
Career (000's)	285.3	305.6
Force Size (000's)	674	701
Percent Career	42.3%	43.6%

Source: FY 81 data from DMDC. FY 87 projections are from the Army. The FY 87 projections are based upon the OSD Budget Submission for FY 83.

d. Summary

Although aggregate shortages of NCO's in the Army persisted through the 1970's, the percentage of personnel in the "top five" enlisted paygrades remained relatively stable over the second half of that decade. Perhaps more serious than the aggregate shortages in the "top five" paygrades was the loss of personnel in the middle 1970's as a result of the career force becoming eligible to retire.

The experience distribution of the enlisted force should improve significantly in the 1980's, as numerically strong cohorts that currently have between five and twelve years of service move into 13 thru 20 years of service. The career force, as a percentage of the enlisted force, should be the largest in recent history by 1987. The improved experience distribution should increase the effectiveness of the force, but will also increase some of the costs. In particular, while the number of military personnel entering retirement will be somewhat lower through most of the 1980's than was the case in the mid 1970's, this number will increase in the 1990's.

No extraordinary measures should be required to improve the experience distribution of the force in the 1980's. Prudent force management coupled with the maintenance of a competitive level of military pay and flexible use of reenlistment bonuses should result in the reduction or the elimination of aggregate shortages in the "top five" paygrades and a more experienced career force.

However, this is not the case for specific MOS's. Table XIX lists selected first-term and career retention rates for MOS's which have retention rates (of either first term or career) of less than 50 percent and which have manning objectives that are increasing.

6. Technology's Implications for Army Manpower

a. General Information

U.S. Army force modernization in the 1980's, in simple terms, means the development and introduction of nearly 200 new systems. This modernization is considered one of the major challenges in Army history. In general, force modernization efforts since World War II have allowed discrete management of each new system, and, at the same

TABLE XIX

RETENTION RATES FOR SELECTED ARMY MOS'S (FY 1981)

JOB DESCRIPTION	MOS	FIRST TERM(%)	CAREER (%)
Field Artillery Radar Crewmbr.	17B	30	60
Remote Sensor Specialist	17M	26	67
Tow/Dragon Repair	27E	34	59
Chaparral/Redeye Repair	27G	38	60
Artillery Repairman	45L	31	48
Utility Equipment Repairman	52C	28	47
Power Generator Repairman	52D	26	53
General Const. Eqpmt Operator	62J	80	15
Track Vehicle Mechanic	63Y	42	53
Attack Helicopter Repairman	67Y	28	63
Medical Lab Specialist	92B	23	48
Electronic Warfare (interpretor)	98J	11	70

Source: U.S. Army Soldier Support Center, National Capital Region, Personnel Supportability Assessment of the Heavy Division 86 transition, v. I, 1982.

time, have not caused major problems in doctrine, organization, or training development. As pointed out by Major General Richard D. Lawrence,

> "This will not be the case in the 1980's. Not only are 200 systems under development and planned for introduction into the inventory in less than 10 years, these systems will be introduced in a peacetime scenario during a period of severely constrained resources." [Ref. 20]

Between now and 1986, more than forty major systems will enter the Army inventory. (This does not include the smaller modifications or add-on systems to the existing weapon systems.) They include a new main battle tank, multiple launch rocket system (MLRS), infantry and cavalry fighting vehicles (IFV and CFV), communications systems, electronic warfare/signal intelligence systems, missle systems, improved antitank systems, fire direction systems and new transportation vehicles. The complexity of these and many other highly technical systems will dictate

major changes and improvements in many facets of the force structure. New doctrine to utilize the capabilities of the new weapon systems must be developed. New training programs will be critical to insure man-machine compatibility, and, without question, the Army will have to access mental group I-IIIA quality soldiers in sufficient numbers to man the weapons systems of the 1980's.

b. Manpower Quality

Much has been written about the quality of military accessions. Questions asked include:

1. are they capable of manning the weapon systems,
2. can they perform essential tasks,
3. can they cope with military life,
4. can they exercise leadership,(etc.)?

Only by identifying the critical requirements and quantifying the relationships between acceptable levels of performance and the abilities, aptitudes, and skills, of the individuals concerned, can these questions be truthfully answered. In an attempt to answer the questions an Army research team, at the Industrial War College, looked at MOS qualifications within the following specific areas:

1. physical capability and capacity,
2. aptitude (skills plus propensity to learn),
3. education (knowledge),
4. motivation,
5. moral standards (demonstrated and potential),
6. socialization (life coping skills, etc.) [Ref. 7].

From this list the team developed a gradation of qualifications (low, mid, high) in order to assess the effects of increasing weapon systems technology on the

required qualifications of the force. First, a judgmental analysis was made to assess the relative importance of currently used qualifications for enlisted military service. The analysis produced the following ranked list:

1. education,
2. aptitude,
3. physical,
4. communications skills (read, write, speak),
5. moral,
6. age,
7. U.S. citizenship,
8. math background,
9. science background,
10. color perception.

In addition, further judgments were made within the above areas,(i.e., relative importance of a high school diploma vs. a general education certificate, etc.) as to their comparative importance. Using these judgments, a numerical scoring system was developed which was then used to obtain gradations levels of low, mid, and high technical qualification groupings. Examples of some Army Military Occupational Specialities (MOS) in each group are located in Appendix A. The profile of the Army by strength in the entry level MOS's using the numerical scoring system discussed above is listed in Table XX.

(Note: The author also attempted to analyze the MOS's by dividing them into semi/technical/highly technical categories. The divisions are based on AFQT scores and consider all entry MOS's. The listing and procedure are in Appendix B.)

TABLE XX

TECHNOLOGY PROFILE OF ARMY ENTRY LEVEL MOS'S (FY 1980)

TECHNICAL GROUP	POP.	PERCENT
High Level	28000	52.0 %
Mid Level	111000	20.2 %
Low Level	411000	74.6 %
TOTAL	550000	100.0 %

Note: these figures include only the entry MOS's.

Source: Department of Defense, Force Structure Considerations For The Mid-1980's: Manpower vs. Technology, National Defense University, Industrial College Of The Armed Forces, 16 July 1980.

c. Force Modernization

The full personnel impact of all the new Army weapon systems has not yet been identified. So, only those systems for which reasonably accurate estimates could be made were sampled. It is felt that the sample represents an accurate reflection of the trends developing, and that further analysis of all the systems will only increase the end points and slopes, but not the direction of the trends. Table XXI indicates the personnel impacts of the sampled Army weapon systems on the three levels of MOS qualification.

The last two entries, Tactical Satellite Communications and Electronic Warfare/Intelligence, are actually an aggregation of numerous new systems for which manpower data exist. Applying the data from Table XXI to the Army strength profile data listed previously will yield the manpower growth trends listed in Table XXII.

Table XXII indicates that the trend, influenced heavily by electronic system increases, will cause a

TABLE XXI

ENLISTED MANPOWER IMPACT OF SELECTED NEW WEAPONS (ARMY 1986)

WEAPON SYSTEM	LOW	MID	HIGH
XM-1 Tank (less DS/GS Maint)	+ 391	0	0
XM-2 Inf. Fighting Vehicle	- 682	- 202	0
XM-3 Cav. Fighting Vehicle	+ 329	0	0
DIVAD Gun	+ 355	+ 379	0
ROLAND A.D. Msl.	- 417	+ 103	0
PATRIOT A.D. Msl.	-4020	- 549	0
TACFIRE (option 3)	+ 541	- 677	0
TACSATCOM	+ 48	+1633	+ 193
EW/INTELL (partial)	+ 127	+ 429	+3059
TOTAL	- 338	+2773	+3252

Notes:
1. Data in the Table are based on 16 divisions of the current (FY1982) mix.
2. Direct/General Support will probably increase in the low and mid ranges.
3. Savings in the low range are caused by a reduction in the Infantry Squad.
4. Savings will occur late in the period only, because the phase-in of the Patriot on top of the Hawk missile system will require the manning of both systems in the interim.
5. Low, mid, high refer to qualification ratings made to determine enlistee requirements for entry level MOS's.
6. + = increases / - = decreases.
7. The basis of this data came from the Basis of Issue Plans (BOIP). The BOIP projects the Organizational placement of a new device and includes changes in equipment, personnel that will be necessary to support the item.

Source: Department of Defense, Force Structure Considerations for the Mid-1980's: Manpower Vs. Technology, National Defense University, Industrial College of the Armed Forces, 16 July 1980.

migration from the lower level to the higher level specialities. This migration will probably be of greater magnitude than indicated when the total manpower cost of modernization is tallied, and will be concurrent with a declining manpower base and numbers of high qualification personnel.

TABLE XXII

TECHNOLOGY DRIVEN MANPOWER TRENDS (ARMY 1980-1986)

Technological Category	Authorized Enlisted Strength (1980)	(1986)	(%)
High Level	28500	+3252	+11.4%
Mid Level	111000	+2773	+ 2.5%
Low Level	411000	- 338	- 0.08%

Note: 1. Entry level occupational specialities only.
2. + = increase / - = decrease.
3. Technological category examples are in Appendix A.
4. Data were developed using 16 divisions of the current (1982) division mix.

Source: Department of Defense, Force Structure Considerations for the Mid-1980's: Manpower Vs. Technology, National Defense University, Industrial College of the Armed Services, 16 July 1980.

d. Training

> "The Army has a major man/machine interface problem. There are not enough qualified people to perform the tasks required to effectively operate, support and maintain current Army systems...The problem is severe and will continue to get worse...The severity of this man/machine crisis and its impact on force readiness, reconstruction, and sustainability require that immediate and extraordinary action be taken." [Ref. 21]

Today's Army is being modernized at a pace and on a scope never before seen in history. The most advanced technology is going into weapon systems. In the rush to "beef up" our forces with the best machines that spaceage technology can deliver, it may well be that not enough attention has been paid to matching the equipment to the competencies of the "real world" soldier.

Training is a critical factor, if not "the" critical factor, in the introduction of advanced weapon systems into the Army. General D.A. Starry, former

Commanding General of the Army Training and Doctrine Command, stated it clearly when he said,

> "...for as technology advances and battle becomes more complex, training soldiers and units to cope with complexity becomes more difficult, and training is the 'glue' that holds it all together." [Ref. 22]

The Army is faced with major training problems, brought about by an ambitious modernization program and an apparent reduction in the aptitude of the average new soldier, as is shown in Table XXIII. Aptitude and functional literacy levels are factors which affect the soldiers trainability and his retention of that training.

> "In WWII, the most advanced American fighter plane was the P-51 Mustang and it was flown by a college graduate pilot. Today, our Army is deploying the XM-1 tank, a weapon system in many ways more complex and difficult to operate and maintain (i.e., it has laser and computer technology) than the P-51 fighter. Yet, these tanks will be manned by soldiers who in many cases will not be high school graduates or able to read on levels any higher than the seventh grade. Technologically superior weaponry is useless without personnel who are able to operate and maintain it." [Ref. 23]

With the complexity of operational equipment, there will be a vast increase in the amount of data that it can handle. With this comes an increase in the responsibility and pressure on the part of the operator to make decisions that he may be incapable of making. Because of the very nature of technology, less complex equipment is not seen in the near future. For example, the mechanic for the M-1 (Abrams) Tank must go to war with seven suitcases full of electronic test equipment [Ref. 17].

Table XXIII shows how the Army NPS accessions look on the basis of the Armed Forces Qualification Test (AFQT). Note in particular the decline in scores from FY 1976 thru Fy 1980. A major research effort was recently concluded that compared FY 1981 recruits with the 1980 youth population. It concluded that, in general, military recruits during FY 1981 scored higher on the AFQT than did the sample

youth. Approximately the same proportion of individuals with above average scores were found in both the 1980 youth population and the group of new accessions. However, the proportion of accessions scoring in the average range was considerably higher than the comparable proportion of the 1980 youth sample.

A comparison of AFQT scores of the 1980 youth population and FY 1981 accessions, by selected demographic characteristics, showed variations in the representativeness of the sexes and the racial and ethnic groups. In general, FY 1981 accessions of both sexes scored higher on the AFQT than did the 1980 youth population. there was no difference of consequence between the proportions of male youth and the reference population. However, AFQT percentile scores for whites were higher, on the average, than those for Hispanics or Blacks. Hispanics, in turn, scored higher than Blacks. This pattern of racial/ethnic group performance was the same on estimates of reading grade level [Ref. 12].

In a congressional hearing on March 7, 1979, the Honorable Robert H. Mitchell of Illinois, stated,

> "...the U.S. Army is having difficulty finding recruits who can read..." Mitchell furthef stated,"...All training manuals for lower echelon troops are to be rewritten for understanding by persons reading at the seventh grade level... Even at that level... About twenty seven percent of the Army's new enlistees will have trouble reading them." [Ref. 24]

The Government Accounting Office (GAO) found that enlistees who were poor readers, when compared to the average enlisted population, tended to have higher discharge rates, experience more difficulty in training, perform less satisfactorily on the job, and lack the potential for career advancement [Ref. 25].

The Human Resources Research Organization (HumRRO) found literacy skills related to military job performance in even low skill jobs. Reading test scores were

TABLE XXIII

PERCENTAGES OF NPS ACCESSIONS SCORING 50+ ON THE AFQT

FY	DOD	ARMY	FY	DOD	ARMY
1961	58.9	53.0	1972	56.3	53.3
1962	57.7	49.3	1973	56.1	53.1
1963	59.1	48.8	1974	58.0	52.5
1964	58.7	50.6	1975	60.7	57.5
1965	57.9	49.5	1976	61.7	48.8
1966	58.7	49.6	1977	47.6	32.1
1967	56.4	48.7	1978	49.2	33.9
1968	54.0	47.1	1979	44.1	28.4
1969	54.2	48.3	1980	44.6	27.8
1970	53.5	48.2	1981	54.4	39.8
1971	53.7	48.1			

Note: Table data includes all NPS accessions.

Sources: Data for 1961-72 are from the U.S. Army Recruiting Command (USAREC), Annual Report of the Qualitative Distribution of Military Manpower, RCS-DD-M(A)664. Data for 1973-81 provided by the Defense Manpower Data Center.

as good or better predictors of job knowledge, and in some cases of job performance, than were AFQT scores. Table XXIV shows the correlations between predictors and job proficiency measures as found by HumRRO [Ref. 26].

The Army has tried to cope with the illiteracy problem by remedial reading programs and by reducing the difficulty of reading material. However, the results may not justify the costs. To reduce the expense the GAO has recommended establishing a minimum RGL for enlistment and a specific RGL for each MOS.

C. SUMMARY

Throughout the history of the U.S., each subsequent generation has been better educated than were their fathers and mothers before them. But, the educational level seems to have crested with the World War II "baby boom" generation

TABLE XXIV

CORRELATIONS BETWEEN PREDICTORS AND JOB PROFICIENCY MEASURES

MOS	PREDICTOR	PROFICIENCY INDEX	
		JOB KNOWLEDGE	JOB PERFORMANCE
Armor Crewman	AFQT	.55	.37
	Reading	.57	.32
	Arithmetic	.49	.31
	Listening	.53	.29
Repairman	AFQT	.44	.32
	Reading	.47	.26
	Arithmetic	.39	.24
	Listening	.40	.38
Supply Spec.	AFQT	.36	.37
	Reading	.40	.40
	Arithmetic	.34	.36
	Listening	.35	.42
COOK	AFQT	.49	.37
	Reading	.56	.34
	Arithmetic	.44	.31
	Listening	.39	.28

Source: Human Resources Research Organization, HumRRO-TR-71-1, Effects of Aptitude (AFQT), Job Experience, and Literacy on Job Performance: Summary of HumRRO Work Units UTILITY and REALISTIC, by J. Vineberg, and others, February 1971.

as aptitude and scholastic test scores are shown to be decreasing. Additionally, with the present trend in the U.S. towards "Zero Population Growth" (approximately two children per family), the pool of youth available for military service is seriously shrinking [Ref. 27].

The Profile of American Youth Study results showed that the Army average AFQT score was 14 percentage points under the 1980 profile youth average in the above average AFQT categories, and 10 percentage points under the profile sample in the below average AFQT categories. The real question then becomes: What qualifications are required by the Army of its enlistees?

The technological trend study indicated that the demand for the high and mid level MOS's will be increasing in relation to the low level MOS requirements.

New equipment supports specific doctrinal (how the Army does business) changes. It has great significance in the way the force is manned, and in how skill inventories are planned. Personnel training programs and facilities must precede weapon introduction and, must exist to sustain system effectiveness in the field. The Army Chief of Staff has stated that,

> "...what is possible through technical sophistication can only be borne out by 'training up' to the weapon complexity... I hope it is clear that training is one of the two paramount concerns I have about our units and the necessary focus of our leaders. (The other is maintenance)...Our ability to manage change hinges critically on our continued competence in training people for the multitude of tasks required to meet the challenges that arise in the Army of today and tomorrow." [Ref. 3]

To meet the soldier/machine interface challenge, the end results must be solutions which draw the most out of both soldiers and machines. To accomplish this, equipment designs must be supportable in terms of manpower, training and the competencies of the soldiers must be matched to the equipment requirements.

The Army is faced with the problem of how to assign a limited number of people to an almost equal number of jobs in a manner that will optimize the Army's effectiveness. The effectiveness of the personnel system is dependent upon how well its supply and demand characteristics are met. If the Army is to realize the combat potential of its improved and future systems it must:

1. Identify the critical occupational requirements,
2. quantify the relationships between acceptable levels of performance and the abilities, aptitudes, skills, (etc.), of the current and projected supply of experienced NCO's and new recruits,

3. Develop an equally sophisticated personnel system to attract, select, classify, train and use its manpower resources.

IV. MANPOWER PROJECTIONS

In this chapter, several "what if" questions concerning numbers of recruits, promotion rates and attrition rates are asked in order to make predictions concerning US Army accession and retention by paygrade, for the period of 1982 thru 1990. The tool used to accomplish this is called "Manmod".

"Manmod" is an interactive computer program based on Markov Chain theory and written in A.P.L. (Applied Programing Language). (The directions for using this program, as it is available at the Naval Postgraduate School, are located in Appendix C.)

The data used to make these predictions are taken from the 1982 base year information (active forces only) discussed in Chapter II. Several scenarios were developed by making assumptions concerning the data and translating it for use as "Manmod" input information. The impact of predictions concerning required acessions, retention and force size (by paygrade) is then discussed with regard to the given scenario.

The following discussion of manpower planning and Markov Chain theory is offered to help the reader understand the Manmod outputs and how they were attained.

1. Manpower Planning

Manpower planning is often defined as the attempt to match the supply of people with the jobs available for them. There are two features of most manpower planning problems which make them suitable for statistical treatment. The first is the concern for aggregates. Manpower planning is

concerned with numbers, that is, with having the right number of people at the right place at the right time. The individual (single person) and aggregate (groups of 100 or more) aspects are closely related, and, in practice, cannot be separated. However, statistical methods are of the most direct relevance for handling the aggregate condition, (i.e., what the average person would do).

The second feature of manpower planning, which calls for statistical expertise, is the factor of uncertainty. This arises both from the uncertainty in the social and economic environment in which the Army operates, and from the unpredictability of human behavior. Any attempt to construct a theoretical base for manpower planning should, therefore, reckon with the element of uncertainty by introducing probability theory [Ref. 28].

2. Manpower Models

A manpower model is essentially a description of the personnel system, it is modeling, together with a set of assumptions about the behavior of the uncontrolled variables. Such assumptions may be based on two kinds of considerations which may be briefly described as empirical or hypothetical. An empirical assumption means one devised from past observation. A simple example is provided by attrition rates. If records of leaving people have similar length of service, it is found that the number is approximately proportional, over time, to the stock of people with that particular length of service. Since this is consistent with the assumption that each individual has the same probability of leaving (not depending on calendar time), the observation might be incorporated into the model. In other words, it is assuming that what has happened in the past will happen in the future [Ref. 29].

In many planning situations, however, the interest is in exploring the future and asking "what if," or hypothetical, questions. Professors Bartholomew and Forbes have written extensively about the potential value of the Markov Theory approaches in modeling these hypothetical questions. Forbes discuss's the Markov approach below.

> "...the manpower system is considered to be composed of mutually exclusive and exhaustive classes or states so that each member of the system may be in one and only one class at a given time...the flows are assumed to be governed by transition probabilities and each class is homogeneous and independent with respect to these probabilities...the basis of the markov assumption is that the transition probabilities depend only on the class or state occupied at present...the equation is deterministic since it only gives the expected numbers...If the model is viewed stochastically a similar equation may be derived...(there are problems with homogeneity of classes)...promotion in reality depends on vacancies, therefore one flow is dependent on another higher up...this does not necessarily imply, however, that the model with constant promotion rates will not give reasonable predictions." [Ref. 30]

The empirical observation that flows are proportional to stocks is a common one which provides the basis for the widespread use of so-called Markov Chain Models.

3. The Basic Markov Model:

The system is divided into (k) categories or grades. The transition probabilities between each of the grades may then be set out in an array as follows:

```
-----------------------------------
P(11).....P(12).....P(1k) |____W(1)
P(21).....P(22).....P(2k) |____W(2)
.""  ..... ""  ..... ""  |____ "".
.""  ..... ""  ..... ""  |____ "".
P(k1).....P(k2).....P(kk) |____W(k)
----------  ----------  ----------
```

Where the element P(ij) is the probability that an individual in grade (i) at the start of the time interval is in grade (j) at the end; While W(i) is the probability that a member of grade (i) at the start has left by the end of the interval.

The assumptions for the Markov Chain Model are that Individuals move independently and with identical probabilities which do not vary over time and that individuals must either stay where they are, move to another grade, or leave, (the rows sum to one).

The matrix P = p is called the transition matrix and the row vector W = w , w , ...w is called the wastage (attrition) vector.

The elements of (p) and (w) will be assigned numerical values in all applications by making hypothetical assumptions about them or by estimating the probabilities from past data. Recruitment will only be allowed in paygrades E1-E5 as specified by the recruitment vector R=r(i) [Ref. 31].

a. Concepts, Terminology and Notation.

The central idea underlying the theory is to regard the organization as a dynamic system of stocks and flows. Stocks are groups classified on the basis of relevant attribute(s), (i.e., paygrade). The numbers in such categories will be called the stocks at that time, (the scenario projections are made on a yearly basis). By denoting the number of categories by (k), the stock in category (i) at time (t) will be written n (T) and the set of stocks as a row vector thus:

$$n(T) = (n(t), n(t), \ldots\ldots n(t).$$

For example the scenario stocks will look as follows:

$$\text{Total Enlisted Force (1982)} = E1\text{-}E3\ (1982) + \ldots . E9\ (1982).$$

The stock vector provides a snap shot of the system but tells us nothing directly about change over time. The stock picture must therefore be supplemented by the numbers that have moved between categories over an interval of time. Consider an interval of time of unit length to be from (T-1) to (T), and denote the number of individuals moving between categories (i) and (j) in this period by $N_{ij}(T-1,T)$.

Flows are those changes in the paygrades resulting from promotion, attrition (i.e., non-reenlistment, retiring) and recruitment. It is important to observe that flows relate to an interval and not a point in time, as is the case with stocks. (Those who stay in the same category are also counted as flows.)

In practice many of the cells will have zero entries, because the Army enlists most people at the lower paygrade E1-E4 levels and except for a few lateral entries or prior service, no one enters active duty above the paygrade of E5. The flows listed in Table XXV are internal to the system and will be described as promotions or demotions. In addition there is a two-way flow (entry/exit) between the personnel system and the "outside (private) world". The attrition flow from category (i) in the interval (T-1,T) will be denoted by $N_{i}(T-1)$ and the vector of attrition flows by $n(T-1)$. The recruitment flow into category (i) in the same interval is $n_{i}(T)$ with the corresponding vector $n(T)$. Notice in the latter case the departure from the convention of identifying the time interval by its starting point (T-1) and the use of the end point (T) instead. This is because recruitment is thought of as taking place after attrition and transfer [Ref. 32].

TABLE XXV

MANPOWER ACCOUNTS FOR THE INTERVAL (T-1,T).

RECRUITS				ATTRITION	BEGINNING STRENGTH
$n_{1}(T)$,	$n_{2}(T)$,	.....	$n_{k}(T)$		
$n_{11}(T-1)$,	$n_{12}(T-1)$,	.....	$n_{1k}(T-1)$	$n_{1}(T-1)$	$n_{1}(T-1)$
$n_{21}(T-1)$,	$n_{22}(T-1)$,	.....	$n_{2k}(T-1)$	$n_{2}(T-1)$	$n_{2}(T-1)$
$n_{k1}(T-1)$,	$n_{k2}(T-1)$,	.....	$n_{kk}(T-1)$	$n_{k}(T-1)$	$n_{k}(T-1)$
$n_{1}(T)$,	$n_{2}(T)$,	.....	$n_{k}(T)$		

Column Totals

Notes: n_{i} = stock values, T = time (present), T-1 = time (last, time), n_{i} = recruits, n_{ij} = flows between categories, n_{i} = attrition from a category, $n_{i}(T-1)$ = beginning strengths of the categories. k= (1,2,...k).

Source: Bartholomew, D.J. and Forbes, A.A., Statistical Techniques for Manpower Planning, Wiley, 1979.

Flows can be classified according to whether the impetus for a move lies at the starting point or at its destination. Thus an individual moves into a higher grade because it was necessary to fill a vacancy arising at that level. Think of that person as being pulled into the higher grade. If, on the other hand, the move to the higher grade is automatic as a result of acquiring a new qualification, the move takes place because of an event occuring at the point of origin. Such flows are called "push" flows.

The distinction between "push" and "pull" flows is often not as clear-cut as the example may suggest. For instance, there can be both a push and a pull element involved in a move when a vacancy arises which can only be filled by a suitably qualified person. Attrition will always be treated as a push flow. Promotion, transfer and recruitment can be treated in either way according to the type of system being modeled [Ref. 27].

Sometimes it is more informative to express the flows as proportions. For example, the recruit, stock and flow elements, in Figure 4.1, are set out in a table of manpower accounts in Table XVI. The row and column totals give the stocks at the end-points of the interval. If the Table elements are expressed as proportions of their row total (see Table XVI,A) the flow rates out of each category are obtained . For example, there are 100 E4's at the beginning of the interval (T-1). During the interval, 10 E4's are promoted to E5, for a 10 percent flow out of E4 (10/beginning strength of 100). There are also 15 E4's that leave the interval (T-1), for a 15 percent attrition rate (15/ 100). And lastly, there are 75 E4's that remained in paygrade E4, for a flow rate of 75 percent (75/beginning strength of 100). The other flow rates may be developed in a similar manner. Such rates are a useful way of expressing the pattern of flows and of identifying problem areas.

It is also useful, though less common, to express the elements in the table as proportions of the column totals, as is in Table XVI(B) This would be appropriate if there was interest in seeing the pattern of flows into a given category, such as recruitment and promotion, rather than the pattern of flows out.

In Figure 4.1, stock and flow information is developed as a three grade heirarchy, network flow diagram. The military is also a heirarchy, because it promotes from within and allows little or no lateral entry. The rectangles in Figure 4.1 represent the paygrades E4 - E6 and the numbers inside them are the stocks at the beginning of the interval. The arrows represent the paths along which flows take place, and the numbers in parentheses are the numbers involved.

TABLE XXVI

TRANSITION MATRIX FLOW RATES

(IN PERCENT)

(A) Flow Rates Out of a Category

PAYGRADE	E4	E5	E6	ATTRITION
FLOW	.75	.10	0	.15
	0	.80	.10	.10
	0	0	.50	.50

Note: the rows percentages sum to 1.

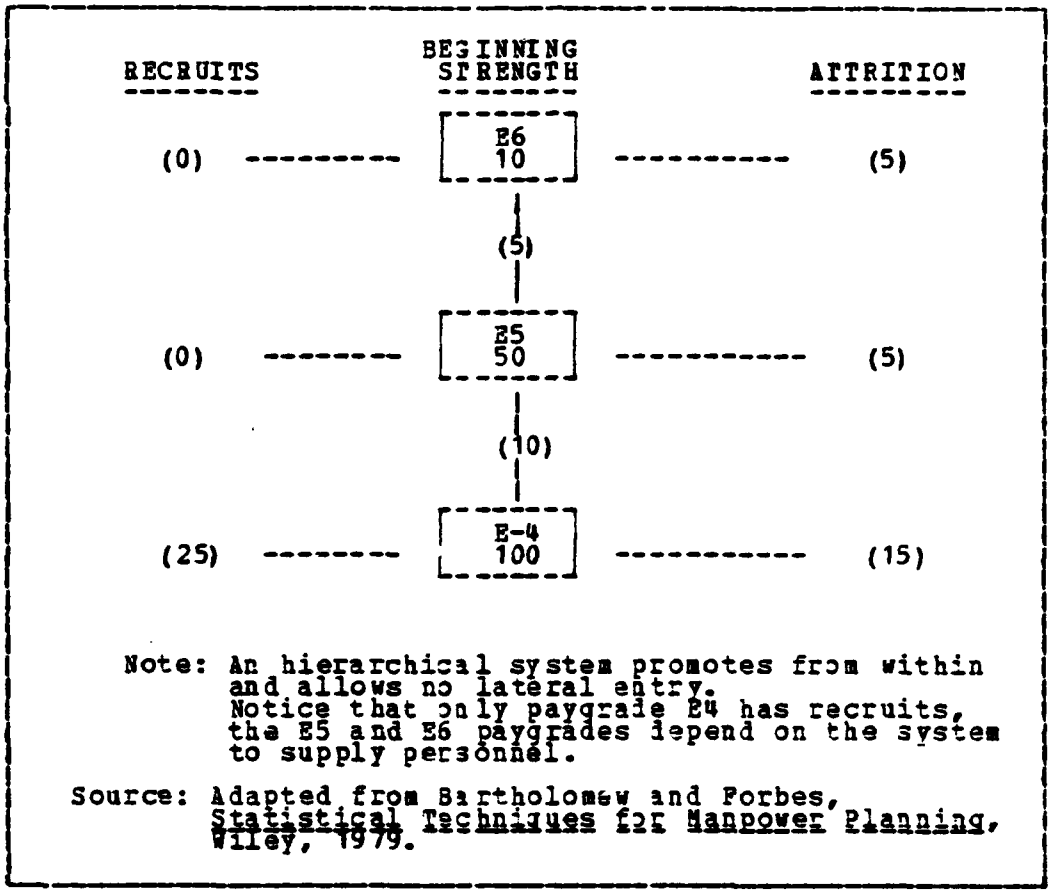
(B) Flow Rates Into a Category

PAYGRADE	E4	E5	E6
RECRUITS	.25	0	0
FLOW	.75	.20	0
	0	.80	.50
	0	0	.50

Note: the column percentages sum to 1.

Source: Adapted from Statistical Techniques for Manpower Planning, by Bartholomew and Forbes. Wiley, 1979.

Table XXVII uses the information in Figure 4.1 to help explain the theoretical values that are expressed in Table XXV. For example, the beginning strengths of E4's at time (T-1) equal 100. Ten E4's are promoted, during the interval,to E5 and 15 E4's attrite (failed/were not allowed to reenlist). At the end of the time interval (T-1), 25 E4's are recruited. The total E4's at time (T)is then equal to 100. The other paygrades may be developed in a similar manner.



Note: An hierarchical system promotes from within and allows no lateral entry. Notice that only paygrade E4 has recruits, the E5 and E6 paygrades depend on the system to supply personnel.

Source: Adapted from Bartholomew and Forbes, Statistical Techniques for Manpower Planning, Wiley, 1979.

Figure 4.1 NETWORK DIAGRAM FOR A THREE GRADE HIERARCHY

b. The Transitional Flow Model

The transitional flow model is a special Markov Chain model which deals with heterogeneous (versus homogeneous) systems in which people are classified according to such things as age, location and paygrade. The Baseline and Unstable Accessions scenarios used in this thesis are transitional flow models.

The following list of questions gives some idea of the purposes which Markov Chain models may serve in a practical manpower planning situation.

TABLE XXVII

MANPOWER ACCOUNTS FOR THE SYSTEM SHOWN IN FIGURE 4.1.

RECRUITS (T)	E4 (25)	E5 (0)	E6 (0)	ATTRITION (T-1)	BEGINNING STRENGTHS
FLOW (T-1)	(75)	(10)	(0)	(15)	(100)
	(0)	(40)	(5)	(5)	(50)
	(0)	(0)	(5)	(5)	(10)
FINAL STOCKS	(100)	(50)	(10)		

Notes: This Table shows the information as set out in a flow pattern in the format of Figure 4.1.

Source: Adapted from Bartholomew and Forbes Statistical Techniques for Manpower Planning, Wiley, 1979.

1. What will the grade structure be at various dates in the future if present patterns of loss and promotion continue?
2. What should the promotion rates and recruitment rates be in order to achieve a desired structure in a specified time?
3. What impact will expansion or contraction of the organization have on the promotion prospects of the grade structure? What can be done to anticipate and minimize the ill effects of such changes?

Table XXVIII shows the basic transitional flow model. It states that the strength, at the end of an interval of time (year) is a function of the beginning year strengths, transitional flow matrix, and the total accessions during the year.

TABLE XXVIII

THE BASIC MANPOWER TRANSITIONAL FLOW MODEL

END STRENGTH AT THE END OF THE YEAR	=	PERSONNEL INVENTORIES AT THE BEGINNING OF THE YEAR	X	TRANSITIONAL MATRIX	+	TOTAL ACCESSIONS FOR THE YEAR

Note: End Strengths = personnel inventories at the beginning of the year multiplied by the transition matrix plus the recruits during the year.
Personnel Inventories = beginning year strengths. In example, Apdx.D/E shows the Army end strength in 1981. Those end strengths plus the recruits from 1981 will equal the beginning strengths for 1982. Transition Matrix is developed from the proportions of the promotion, retention and attrition flows, by paygrade, during FY 1981.

Source: Adapted from Rand Note WD-515-MRA&L, Enlisted Supply in the 1980's, February 1980.

4. Alternative Supply/Demand Scenarios

a. Introduction

This section will discuss the Baseline and Unstable Accession scenarios using output from the MANMOD program. The Baseline and Unstable Accessions scenarios are developed from the same beginning inventory and transition matrix. However, they differ as to the number of enlistees they access yearly. Appendix D gives the MANMOD inputs/outputs for the Baseline scenario, and Appendix E gives the MANMOD inputs/outputs for the Unstable Accession scenario.

b. Scenario Assumptions

Model assumptions are made in an effort to isolate a specific "what if" situation by controlling variables (which are uncontrollable in real life) so that an analysis of the situation can be made. Therefore, the

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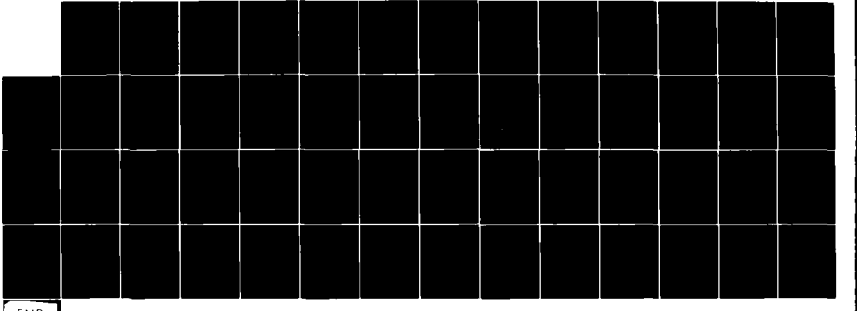

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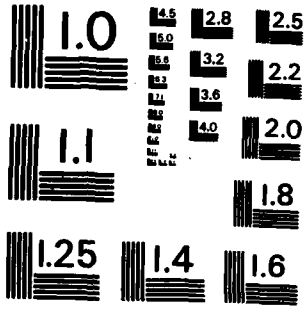

closer the assumptions are to the reality of a future situation, the more valid the results should be. In other words, the assumptions provide the base from which the prediction and conclusions are developed, as well as the range of their accuracy. The following assumptions were used in developing the supply/ demand scenarios. The scenarios (Baseline and Unstable Accessions) use the same basic assumptions with any differences that exist being discussed in the results of the given scenario. The assumptions are:

1. The 1981 stock values (paygrade strengths) are accurate.
2. The transition matrix is accurate and will remain constant thru 1990. This means that no changes are anticipated in, for instance, attrition, retention, promotion, or retirement rates.
3. Male AFQT category I,II, and III accessions will be available as predicted by the Fernandez (RAND) Model (as shown in Table VII).
4. Female AFQT category I,II and III accessions will continue to be available at the 17000 rate thru 1990. (Note: This is assuming the limit of 65000 enlisted women is held constant).
5. Prior service personnel will be accessed at higher rates than the present service quotas allow. (Note: This view is taken under the theory that they would cost less to train and would be more likely to reenlist (be careerists) than non-prior service accessions.)
6. Non-prior service, mental category IV's accessions will continue to be available in numbers greater than the Congressional Policy will allow to enlist. (Note: At present the constraint is 20% of the total accessions.)

7. Civilianization (civilian substitution) of military jobs is an acceptable means of reducing force structure and cutting back on accession requirements. (Note: In particular, the Contracting of Industrial Type Activities (CITA) may offer the possibility to relieve the military from force requirements and reduce the secondary labor costs that come with permanent hire employees.)
8. Lateral Entry is a viable, accepted program in the Army. (Note: Lateral entry into the military is receiving more attention these days due to the intense technical training required of the average G.I. The question is, whether or not it is more cost effective to train an enlistee or would it be better to hire direct?)
9. Lastly, and importantly, the aggregate and paygrade requirements listed in Appendix F are those necessary to attain an 18 Division force. (Note: In reality it is evident that a more technical force would also be a more career intensive force. However the Requirements estimate maintains the same percentages as the Authorized paygrades are in the 1981 Army Program Objective Memorandum.)

5. Results (Baseline Scenario)

a. Aggregate Manning Capability of Baseline

This scenario grows the force over two separate periods, FY82-86 and FY86-90. The methodology consists of determining the growth requirements (found by subtracting the beginning strengths from the end strengths) and dividing them over the intervening years. The figures in Table XXIX indicate that, given the assumptions for the Baseline

Scenario, all aggregate requirements can be met in manning an 18 division force by 1990. However, the number of AFQT category IV accessions increase from 7,700 in 1982 to 21,900 in 1990. (The supply of NPS Male AFQT I-IIIA accessions was estimated using the Rand model. The results can be found in Table VII.) To improve the quality of the force, it may be necessary to accept more women, develop a comprehensive lateral entry program, and/or civilianize military positions. Notice also that an important aspect of this scenario is that prior service accessions are greater than present service policy constraints allow. Without this policy change the requirements could not have been met after 1983. (Note: prior service accessions equaled 19,900 in 1981, whereas in the scenario, they are doubled to equal 39,800 from 1983-1990.) The total force grows by 8 percent by 1986 (17 divisions) and only 3 percent thru 1990 (18 divisions). These increases occur with The recruits never exceeding 140,000. This gradual growth should cause fewer problems for the recruit training, and personnel systems.

b. Paygrade Manning Capability Of Baseline

The paygrade strength changes should be observed and compared on a yearly basis. Note in particular the growth in the E5-E7 paygrades from 1981-1986. The following information describes the paygrade data in Table XXX and depicts changes over the period FY 1982-86, when the force expands to 17 divisions and increase by 40,800 soldiers. You will observe that the paygrades in the Baseline scenario are increased slowly and create very little turbulence in the personnel system. The Unstable Accessions scenario is quite the opposite, with a great deal of variance and turbulence.

TABLE XXIX

BASELINE SUPPLY / DEMAND SCENARIO

# DIVISIONS	16	17	18
FY	1982	1986	1990
ACCESSION REQUIREMENTS	132.8	139.3	139.7
SUPPLY POOL			
NPS Male Accessions AFQT Category I,II,III	78.3	63.6	61.0
Women Accessions AFQT Category I,II,III	17.0	17.0	17.0
Prior Service	29.8	39.8	39.8
NPS Male Accessions AFQT Category IV.	7.7	18.9	21.9
Civilian Substitution and CITA.	--	--	--
Lateral Entry Program	--	--	--

Note 1. Accession requirements are based on the computer run in Appendix D (Baseline).
2. NPS Male accessions are based on the Rand Model results listed in Table VII.
3. The other elements are based on the Scenario assumptions.
4. NPS (Non-Prior Service)
5. AFQT (Armed Forces Qualification Test)
6. Using this scenario it was not necessary to use the civilian substitution or lateral entry supply pools.

Source: Author, using MANMOD data from Appendix D, Rand Model data from Table VII, and the scenario assumptions.

1. the number of E1's decrease and then gradually increase again from 83 to 86,
2. the number of E2's increase and then remain almost constant through the period,
3. the number of E3's increase by 8500 quickly, and then maintain a gradual growth rate of about 1000,

4. the number of E4's decrease in 82-83 and then maintain a gradual growth pattern of about 1600,
5. the number of E5's increase quickly in the first year and then settle down to a gradual growth rate of about 1500,
6. the numbers of E6's grow at a rate of 3000 over FY 82-84 and then increase at a decreasing rate through FY 1986,
7. the numbers of E7's maintain almost constant growth of about 2000 over the period,
8. the numbers of E8's grow at a modest , but increasing rate through FY 1986,
9. the numbers of E9's grow yearly in multipies of 15.

In summary, the growth patterns in each paygrade remain constant over the years. In comparison, note the changes in the FY 1985-86 Unstable Accessions data data over the same period.

The following discussion describes the Baseline scenario paygrade manning trends over the period from FY 1986-90, when the force grows to 18 divisions and increases by 25,500 soldiers.

1. the numbers of E1's decrease after the FY 86 growth requirement, and then settle down to modest yearly increases of about 600,
2. the numbers of E2's remain almost constant, with slight growth at the end of the period,
3. the numbers of E3's have a lot of variance during this period,
4. the numbers of E4's taper off in their growth, and continue to grow at a decreasing rate through 1990,
5. the numbers of E5, E6, and E7's all grow at decreasing rates,

6. the number of E8's growth levels off at 522 yearly,
7. the numbers of E9's continue to maintain modest yearly growth increases.

In summary, the Baseline paygrades maintain reasonable (no large variances) growth patterns that should be maintainable beyond 1990.

6. Results (Unstable Accessions Scenario)

a. Aggregate Manning Capability of Unstable Accessions

This scenario uses the same inputs as the Baseline scenario, except that it attempts to provide the accessions as they are required. The result is that yearly force increases vary by large amounts and so do the number of accessions. This kind of system variance would cause undue stress on the recruit, training and personnel systems, not only during the requirement year but also in the future. However, the accession requirements shown in Appendix F should be within the capabilities of the Army recruiters, except in FY 1986. In that year there is a projected increase of 34,900. This total force increase would require an increase in accessions of 27,900 over the previous year. The result is a shortage of 10,700. This equals a total force growth of 6 percent in one year. Note the "bubble" of accessions as they move thru the system, especially in the grades of E6 and E7. The model manages to make up the difference by 1990, so a temporary solution would have to be developed during FY 1986. Some of the possibilities include:

1. increase retention rates through bonuses, other incentives,
2. increase enlistment rates,

TABLE XXX

PAYGRADE MANNING TRENDS OF BASELINE

17 DIVISIONS

PAYGRADE	STRENGTH CHANGES			
FY	82-83	83-84	84-85	85-86
E1	-1064	+ 412	+1040	+1144
E2	+1853	+ 198	+ 219	+ 277
E3	+8121	+1567	+ 841	+1098
E4	-8349	+1343	+1811	+1656
E5	+4481	+1317	+1248	+1293
E6	+2922	+3006	+2569	+2217
E7	+1933	+1972	+2017	+1994
E8	+ 287	+ 357	+ 413	+ 458
E9	+ 15	+ 29	+ 43	+ 60

18 DIVISIONS

PAYGRADE	STRENGTH CHANGES			
FY	86-87	87-88	88-89	89-90
E1	-1414	+ 494	+ 645	+ 643
E2	- 49	- 43	+ 121	+ 156
E3	+ 687	- 559	+ 316	+ 610
E4	+1474	+1121	+ 319	+ 501
E5	+1245	+1199	+1071	+ 819
E6	+1947	+1728	+1550	+1387
E7	+1929	+1841	+1739	+1633
E8	+ 491	+ 513	+ 522	+ 522
E9	+ 73	+ 88	+ 99	+ 110

Note: (1) The data was developed by subtracting the previous years paygrade strength from the present years paygrade strength.
(2) + = increase, - = decrease.

Source: MANMOD data from Appendix D.

3. access more women,
4. "use " the lateral entry program,
5. use the Contracting of Industrial Type Activities (C.I.T.A.) program.

The requirements are met but at what price in training and quality of performance?

TABLE XXXI

UNSTABLE ACCESSIONS SUPPLY / DEMAND SCENARIO

# DIVISIONS	16	17	18
FY	1982	1986	1990
ACCESSION REQUIREMENTS	131.1	159.0	140.0
SUPPLY POOL			
NPS Male Accessions AFQT Category I,II,III	78.3	63.6	61.0
Women Accessions AFQT Category I,II,III	17.0	17.0	17.0
Prior Service Accessions	29.8	39.8	39.8
NPS Male Accessions AFQT Category IV	26.6	27.9	27.9
Civilian Substitution and CITA	--	10.7	--
Lateral Entry	--	--	--

Note 1. Accession requirements are based on the computer run in Appendix E (Trouble).
2. NPS Male accessions are based on the Rand Model results listed in Table VII.
3. The other elements are based on the Scenario assumptions.
4. NPS (Non-Prior Service)
5. AFQT (Armed Forces Qualification Test)
6. Using this scenario it was necessary to use the civilian substitution or lateral entry supply pools.

Source: Author, using MANMOD data from Appendix E, Rand Model data from Table VII, and the scenario assumptions.

b. Paygrade Manning Capability of Unstable Accessions

The following discussion will describe the data from Table XXXII. The period to be discussed will include FY 1982-86, in which the Army grows from 16 to 17 divisions and increases by 40,800 soldiers. The Unstable Accession scenario differs slightly from the Baseline in the way its

recruit proportions are developed. The proportion is adjusted only once for the prior service entrants, whereas, the Baseline scenario is adjusted twice (see Appendices D and E). The resulting paygrade trends are:

1. the numbers of E1's initially grow at a decreasing rate, but end with an increase of 1513 in the FY 85-86 time frame,
2. the numbers of E2's vary throughout the period, and also end with a growth of 2809 in the FY 85-86 time frame,
3. the numbers of E3's vary greatly, from +6000 to a -1200 to +1200 and increase again to +6000,
4. the numbers of E4's decrease at a decreasing rate until FY 85-86, when they increase by 1513,
5. the numbers of E5's decrease yearly from FY 83-86 at a rate of approximately 600,
6. the numbers of E6's increase, but at a decreasing rate through FY 86,
7. the numbers of E7's maintain an almost constant growth of approximately 2000 over the period,
8. the numbers of E8's and E9's grow in modest amounts over the period.

In summary, the lower paygrades (E1-E5) are in a constant state of change throughout the period. While the upper grades maintain modest growth rates, some in decreasing amounts.

This paragraph will discuss the data in Table XXXII for the period FY 1987-90, in which the Army grows from 17 to 18 divisions and increases by 25,500 soldiers. The paygrade trends are:

1. the number of E1's begin the period with a large decrease and then grow at a decreasing rate until 1989 when they begin to decrease again,

2. the numbers of E2's decrease to almost 1000 in 1988 but increase slowly until 1990 when they grow slightly,
3. the number of E3's vary greatly over the period, from +11666 to -6641, and finally finish the period with a growth of 964,
4. the number of E4's grow in large amounts for the first two years, but then grow at a decreasing amount at the end of the period,
5. the number of E5's grow at a steep rate through 1989 and then drop off in 1990,
6. the numbers of E6's grow at a decreasing rate through 1989 and increase in 1990,
7. the numbers of E7's and E8's grow at a decreasing rate throughout the period,
8. the numbers of E9's maintain a constant, but modest growth throughout the period.

In summary, the lower paygrades are in a constant state of flux, while the upper paygrades either decrease or maintain a constant growth pattern.

c. Aggregate Comparisons of Baseline and Unstable Accessions

A comparison of the Baseline and Unstable Accession scenarios consists of a discussion based on Table XXXII. During this discussion, consider that the main difference between the two scenarios is the manner in which they "grow". The Unstable Accessions scenario grows to meet the next year's requirements. Baseline, on the other hand, "grows" the force in two stages, FY 1982-86 and FY 1986-90. The Baseline methodology consists of averaging the differences between the beginning years and averaging the increases over the intervening years. The result is that

TABLE XXXII

PAYGRADE MANNING TRENDS OF UNSTABLE ACCESSIONS

17 DIVISIONS

PAYGRADE	STRENGTH CHANGES			
FY	82-83	83-84	84-85	85-86
E1	+ 4535	+1114	+4588	+21119
E2	+ 701	- 153	+ 573	+ 2809
E3	+ 6507	-1148	+1028	+ 6272
E4	-13066	-2471	-1614	+ 1513
E5	+ 3339	- 523	- 854	+ 691
E6	+ 2846	+2754	+2070	+ 1488
E7	+ 1910	+1944	+1959	+ 1881
E8	+ 285	+ 354	+ 408	+ 451
E9	+ 15	+ 29	+ 43	+ 59

18 DIVISIONS

PAYGRADE	STRENGTH CHANGES			
FY	86-87	87-88	88-89	89-90
E1	-16488	+2081	+1749	- 811
E2	+ 300	- 971	- 226	+ 79
E3	+11666	-6641	+ 5	+ 964
E4	+ 5465	+8984	+ 402	+ 352
E5	- 187	+1302	+2792	+1966
E6	+ 1050	+ 804	+ 851	+1120
E7	+ 1741	+1567	+1393	+1256
E8	+ 478	+ 489	+ 484	+ 469
E9	+ 73	+ 86	+ 97	+ 105

Note: The data were developed by subtracting the previous years paygrade strength from the present year's paygrade strength, + = increase, - = decrease in strength.

Source: MANMOD data from Appendix E.

the Baseline trends are constant, while the Unstable Accession scenario trends are varying and turbulent. Notice in particular the "growth" differentials (differences between the scenarios) in Table XXXIII. In 1984, Baseline has grown five percent and developed a growth differential of 22,000 over the Unstable Accession scenario. However, the

growth differential changes by FY 1986, as the Unstable Accessions scenario increased its force by seven percent and 43,100 in two years, in order to meet the FY 1986 aggregate requirement of 726,700. Both scenarios made the aggregate goal for FY 1986, allowing the increase to 17 divisions.

The Baseline scenario again develops a growth differential (1800) in FY 1987, and maintains a small one (500) in FY 1988. However, in FY 1989, Baseline had its first significant shortage (1200). But, by FY 1990, the shortage is reduced to 300. Both scenarios met the goal requirements for the FY 1982-86 time period, but the Baseline scenario had a shortage in FY 1989. However, the Baseline scenario provided the best planned growth pattern of the two scenarios. The Unstable Accessions scenario "grew" the force yearly by "leaps and bounds" and was able to meet all required aggregate strength requirements.

d. Paygrade Percentage Comparisons of Baseline and Unstable Accessions

A comparison of the paygrade percentage supply will consist of a discussion of the data in Table XXXIV. The table contains the paygrade percentages of the Baseline, Unstable Accessions, and the "goal" requirements, for FY 1982,86 and 90. It should be noted that there is a difference in the way the scenarios are developed which would have an impact on this comparison. The difference is that the Unstable Accession scenario did not have the second recruit proportion adjustment (see Appendices D , FY 1983). This difference could impact on the fill rates of the Paygrades E5-E7.

In FY 1982, the Unstable Accession scenario is closer to the "goal" requirements of paygrade E6 and E8, while Baseline is closer in E4's. Then in FY 1986, the

TABLE XXXIII

AGGREGATE SCENARIO COMPARISONS

END FY	UNSTABLE SCENARIO STRENGTHS	GROWTH DIFFERENTIALS	BASELINE SCENARIO END STRENGTHS
82	683.7 101 %	+ 1.7 + 1 %	685.4 102 %
83	681.7 101 %	+13.9 + 2 %	695.6 103 %
84	683.6 101 %	+22.2 + 4 %	705.8 105 %
85	691.8 102 %	+14.2 + 4 %	716.0 106 %
86	726.7 108 %	- 0.5 0	726.2 108 %
87	730.8 108 %	+ 1.8 + 1 %	732.6 109 %
88	738.5 109 %	+ 0.5 0	739.0 109 %
89	746.5 111 %	- 1.2 - 1 %	745.3 110 %
90	752.0 111 %	- 0.3 0	751.7 111 %

Note: 1. The Unstable Accession data are equivalent (i.e., percentages are based with 1981 = 100%).
2. Growth differentials are the differences between the two scenario strengths.
3. Baseline strengths are from Appendix D; Unstable Accession strengths are from Appendix E.

Source: Author

Baseline scenario is closer to the "goal" requirements of all paygrades, except for E9.

In FY 1990, the Unstable Accessions scenario is closer to the "goal" requirements of paygrades E7,E8, and E9, and Baseline is closer to the "goal"requirements of paygrades E1-E6. Over the period, from FY 1982-90, the

Baseline scenario maintained paygrade percentages closer to the paygrade "goal" requirements than did the Unstable Accessions scenario.

TABLE XXXIV

SCENARIO COMPARISONS BY PAYGRADE PERCENTAGES

PAY GRADE	BASELINE SUPPLY FY82	BASELINE SUPPLY FY86	BASELINE SUPPLY FY90	REQUIREMENTS FY 82-90	UNSTABLE ACCESSIONS SUPPLY FY82	UNSTABLE ACCESSIONS SUPPLY FY86	UNSTABLE ACCESSIONS SUPPLY FY90
E1-3	33.39	33.52	32.60	27.7	33.41	36.93	34.43
4	27.10	25.10	24.70	29.0	26.87	23.0	24.36
5	18.16	18.30	18.25	19.2	18.17	17.27	17.50
6	11.80	12.63	13.08	13.4	11.85	12.40	12.50
7	7.15	7.85	8.53	7.9	7.17	7.80	8.34
8	1.90	2.10	2.27	2.2	1.97	2.06	2.30
9	0.50	0.50	0.57	0.6	0.56	0.54	0.57

Note: 1. Baseline data were developed from Appendix D, Unstable Accessions data were developed from Appendix E, and the Requirements data was taken from Appendix F.

2. EXAMPLE: 33.39% by E1-E3 under FY82 (Baseline) means that 33.39% of the aggregate force are expected to be E1-E3 in FY82 under that scenario. The 27.7% under Requirements means that 27.7% of the Army's enlisted billets are presently E1-E3's and with growth are expected to remain the same.

Source: Author

V. CONCLUSIONS

It is paradoxical that during a time when the traditionally used manpower pool is decreasing, that one of the most challenging issues facing the Army in the 1980's is how to cope with the biggest influx of weaponry and equipment since World War II. The Army's Force Modernization Program is expected to have a profound effect in many major areas, ranging from readiness to training methods, to unit structure. These "tools of battle" are expected to touch off a period of intensive change, perhaps the most sweeping in the Army's history . The changes will encompass practically every activity connected with putting and keeping a combat force in the field. New doctrine will have to be developed to fully exploit the capabilities of the new systems. Tactics, unit organization, missions, operations, training--especially training . Training will undergo change as the Army adjusts itself to the new "electronics age" of weaponry.

> " If human resources are the ultimate wealth of a nation, so also are they its strength. All the sophisticated weaponry in the world will not compensate for a fighting force which is poorly organized, deficiently motivated, ill-trained and defectively deployed. In fact, the growing complexity of armaments and of military strategies requires increasingly better trained and educated manpower." [Ref. 33]

Given "stable" military requirements, a recovery in the civilian economy, and a smaller prime supply pool to meet these needs, labor will become an increasingly expensive resource for the military. As labor becomes a more valuable resource, education and training must be seen in a new light.

Manpower planning is a means of providing early warning of such problems, provided that the assumptions upon which it is based are sound. Even if assumptions are not always correct (as is inevitable, particularly on the demand side) the existence of the data makes it easier to assess the effect of sudden changes and even to influence decisions by showing in advance the manpower implications. Planning of this kind shows the implications of current recruitment policies or retirement and attrition levels.

By using the APL prediction model, MANMOD, aggregate and paygrade projections were made about the feasibility of manning 18 Army Divisions by 1990. The resultant predictions indicate that the Army could meet the aggregate manning requirements by 1990. In accomplishing this, the total accession requirements could remain less than 140,000 and still allow for the required eight percent growth by 1986 and a total growth of eleven percent by 1990. However, the paygrade predictions fall short of the ideal requirements (as listed in Appendix F). The shortages are as follows:

1. the number of E9's is slightly under requirements by (.3%),
2. the number of E8's is over requirements by (.7%),
3. the number of E7's is over requirements by (.63%),
4. the number of E6's is (1%) short of requirements,
5. the number of E5's is (1%) short of requirements,
6. the number of E4's is short of requirements by (4%),
7. while the number of E1-E3's is over requirements by (5%).

The implications involved with the lower paygrades, although large in actual numbers, are not totally disastrous. The Army manning policy allows individuals to fill positions which are two grades higher, or one grade under

their present paygrade. Personnel who are E1-E3's can be redistributed to meet the E4 and E5 requirements and that the overage in E7's can be used to fill the shortage in the E6 requirements. This means that the aggregate numbers are adequate, but not necessarily optimal. That is to say, it is a solution, but not the only solution. Through manipulation of paygrade policy, the combination of paygrades from either scenario would meet the paygrade requirements.

The author considers the Baseline scenario to be the better of the two considered, in that it allows the force structure to expand more gradually over time. That means that training programs, recruiter efforts and personnel policy will not be stretched or expanded to the extremes in meeting aggregate force requirements.

Issues not shown directly by the models but alluded to in Chapter III still require Army attention. The Army is involved in a large-scale modernization program as a result of extensive research and development initiated in the early 1970's. Therefore, the numbers of high quality personnel required to operate and maintain these advanced systems is estimated to increase. Available recruits will probably continue to reflect the declining efficiency of the present educational system. Additionally, it will be necessary to increase the accession rate of category IV recruits to maintain recruit quantity, due to the decline of the recruit source pool. Therefore, the Army must continue to estimate its target population's capabilities, compare them with the demand requirements and assess the implications to the Army Battle-field Development Plan. In some cases remedial training or longer training times may be able to produce the basic skills required to perform Army jobs. In other cases, the equipment may have to be modified. The Army leadership is talking about training up to the equipment, but at what price?

Throughout the Army there is an increasing awareness that the past worry of equipping the man is being replaced with the worry of manning the equipment and the realization that manpower is a resource which requires efficient management and utilization. Winston Churchill summed up the task when he said,

> " It is no use saying, 'We are doing our best.' You have got to succeed in doing what is necessary." [Ref. 34]

APPENDIX A

ARMY MOS CATEGORIZATION EXAMPLES

The following Figures hold examples of the categorization process used in Chapter III, as written by the study group at the National Defense University (1980). The study team was attempting to establish trends in MOS growth as a result of the modernization program that the Army is implementing. The procedure is described in Chapter III Section B,3.

The categorization process used established three ranges, low, mid and high as referring to the entrance qualifications for a given Army MOS.

MOS	Description	Min. Entry Qualifications	points
11B	Infantryman	Phy Profile 1111211	2
		Aptitude Score:	
		Combat 90	0
		Color Perception: (red/green)	1
		No Math/Science rqd:	0
		No Education Reqmt:	0
		No Security Clearance Requirement:	0
		No Citizenship Requirement:	0
		TOTAL	3

Figure A.1 LOW LEVEL MOS CATEGORY (EXAMPLE)

MOS	DESCRIPTION	MIN. ENTRY QUALIFICATIONS	points
91S	Environmental Health Spec.	Phy. Profile 2222211	1
		Aptitude: ST 100 (skilled technical 100)	1
		Color Perception (Normal)	2
		HS Algebra Reqd	2
		HS Chemistry Reqd	3
		No HS degree/GED Reqd.	0
		No Security Clearance Required	0
		TOTAL	9

Figure A.2 MID LEVEL MOS CATEGORY (EXAMPLE)

MOS	DESCRIPTION	MIN. ENTRY QUALIFICATIONS	points
98C	Electronic Warfare Signal Intelligence Specialist	Phy. Profile 2222212	1
		Aptitude: ASVAB SCORE (skilled technical 115)	4
		Color Perception (none required)	0
		No Math/Science Reqd	0
		GED Required	3
		Top Secret Clearance Plus SI Required	4
		US Citizenship Reqd	1
		TOTAL	13

Figure A.3 HIGH LEVEL MOS CATEGORY (EXAMPLE)

APPENDIX B

ARMY MOS CATEGORIZATION PROCEDURES

The purpose of this appendix is to categorize the Army MOS's into technical categories based upon AFQT scores. The basic information was obtained from a member of the Military Manpower Task Force in January 1982. Their measure for the categorization was the AFQT score. The AFQT score is computed by adding the arithmetic reasoning, word knowledge, paragraph comprehension and half of numerical operations test scores from the ASVAB.

TABLE XXXV

ASVAB SERIES 8, 9, AND 10 SUBTESTS

TEST	ACRONYM
1. Numerical Operations	NO
2. Coding Speed	CS
3. Word Knowledge	WK
4. Arithmetic Reasoning	AR
5. Paragraph Comprehension	PC
6. Math Knowledge	MK
7. Electronics Information	EI
8. Mechanical Comprehension	MC
9. General Science	GS
10. Automotive Shop	AS

Source: TRADOC Report ACN 64024, Soldier Capability--Army Combat Effectiveness (SCACE) by J. Toomepuu, April 1981.

The aptitude areas are based on combinations of ASVAB subtests. The standard scores for aptitude areas are normed similar to IQ tests, with a score of 100 as the average, and a range from 40 to more than 150. In addition to the listed

TABLE XXXVI

ARMY APTITUDE AREAS, ASVAB 8, 9, and 10

Aptitude Area	Subtests
CO (Combat)	CS+AR+MC+AS
FA (Field Artillery)	CS+AR+MC+MK
EL (Electronics)	AR+MK+EI+GS
OF (Operators/Food)	NO+VE+MC+AS
SC (Surveillance/Comm.)	NO+CS+VE+AS
GM (General Maint.)	MK+EI+GS+AS
MM (Mechanical Maint)	NO+EI+MC+AS
CL (Clerical)	NO+CS+VE
ST (Skilled Technical)	VE+MK+MC+GS
GT (General Technical)	VE+AR

Source: TRADOC Report ACN 64024, Soldier Capability--Army Combat Effectiveness (SCACE) By J. Toomepuu, April 1981.

subtests, a verbal score (VE), made up by adding Word Knowledge and Paragraph Comprehension subtest scores, is used to compute aptitude area scores. The subtests are listed in Table XXXV, and aptitude area composites in Table XXXVI.

Tables XXXVII-XLI delineate the categorization of the Army MOS's as determined by the AFQT entry scores.

TABLE XXXVII

SEMI-TECHNICAL MOS'S (AFQT SCORE =75-90)

00J, 00Y, 00Z, 03C, 05B, 11B,C,H,M, 12B,C,F, 13B,
16B,D,F,P,R,S, 19D,E,K,Z, 26D, 35B, 36C,D,E,K, 41C,J,
43E,M, 44B 45B,T, 51B,C,K,M,N,
54E, 55B, 57F,H,61B,F, 62B,E,F,G,H,J,N,
63B,H,J,W, 64C,Z, 65G,
68M, 72E,G,H, 76V,W,X, 81C,
82E, 83F, 84C,94B, 95C, 96C.

Source: Basic Data obtained from the Military Manpower Task Force and adapted by the Author using DA Circular 611-81-4, dated 12 February 1982.

TABLE XXXVIII

TECHNICAL MOS'S (AFQT SCORE = 91-99)

00B,E, 02B,C,D,E,F,G,H,J,K,L,M,N,P,Q,R,S,T,Z, 05C,D,G,H,K,
12E,Z, 13C,E,Y, 15D,E, 16C,E,G,H,J,T,Z, 17C,K,L,M, 21G,L,
22L,N, 23N,U,W, 24H,J,K,L, 25J,L, 26B,C,H,Q,R,T,V,
27B,C,D,E,F,G,H,N, 31H,M,V,Z, 32D,H,S, 33S, 34B,Y,
35C,E,F,K, 41B,E,G, 42C,D,E, 44E, 45D,E,G,K,L,N,Z, 46N,
51G,H,P,R,T,Z, 52C,D,E,G, 53B, 54C,Z, 55G,X, 63E,N,
65B,D,E,F,H,J,K,Z, 68J, 71C,G,L,M,N,P, 73C, 74B, 75B,C,E,
76C,J,P,Y,Z, 79D, 81B,Z, 82B,C,D, 84B,F,T,Z,
91B,C,D,E,F,H,J,L,N,Q,S,T,U,V,W,Y, 92B,C,D,E, 93E,F, 94F,
96B,D,H,Z, 98G.

Source: Basic Data Obtained from the Military Manpower Task Force and adapted by the Author using DA Circular 611-81-4, dated 12 February 1982.

TABLE XXXIX

HIGHLY TECHNICAL MOS'S (AFQT SCORE = 100+)

01H, 13F,H,R,W,Z, 15J, 17B, 24C,E,G,M,N,P,Q,R,S,T,U,V,
26Z,F,K,L,M,N,Y, 27Z 31E,J,S,T, 32F,G,Z, 34C,E,F,H,J,K,Z,
35G,H,L,M,P,R,U, 36H,L, 55D,Z, 61C,Z, 63D,G,S,T,Y,Z,
67G,H,M,T,U,V,W,X,Y,Z, 68B,D,F,G,H,K, 71D,E,O,R,
73D,Z, 74D,F,Z, 75F,Z, 91G,P,R, 93H,J, 95B,D, 97B,C,
98C,J.

Source: Basic data obtained from the Military Manpower Task Force and adapted by the Author using DA Circular 611-81-4, dated 12 February 1982.

TABLE XL

US ARMY SENIOR RATINGS (SKILL ENTRY LEVEL, 2 OR HIGHER)

(Semi-tech)---00J,U,Z, 19Z 62M, 64Z,

(Technical)---00E, 02P,Q,R,Z, 12Z, 13Y, 16Z, 23H, 31Z, 45Z,
51P,T,Z, 52E, 54Z, 55Z, 65Z 76Z, 79D,
81Z, 84T,Z, 96Z.

(High-Tech)---13W,Z, 24R,Y, 27Z, 32Z, 34C,E,F,H,J,K,Z,
35P,U, 55Z, 61Z, 63Z, 67W,Z, 68K, 71E,Z,
74Z, 75Z, 95D.

(Non-occupational)---00D, 09D,R,S,T,W.

Source: Author using DA Circular 611-81-4, dated 12 February 1982.

TABLE XLI

MOS'S REQUIRING HIGH ELECTRICAL APTITUDE

24C,E,G,M,N,P,Q,U	26E,K	31E,J,S,T	32F	34E,F,H	
35G,H	36L	71Q,R	73D	91G	97B,C	98C,J

Note: This Table was developed because of the extensive growth of electronics within the Army.

Source: Military Manpower Task Force.

APPENDIX C

DIRECTIONS FOR THE USE OF MANMOD

This appendix describes and gives an example for using the APL workspace as is required for Manmod. This workspace is used to solve the basic transition equation described in Statistical Techniques for Manpower Planning, by Bartholomew an Forbes.

After the Manmod program is copied onto your A disk, the following steps are required to accomplish a computer run.

EXAMPLE: Baseline Scenario

Note: "quotation marks" designate those words that the operator must type in.

STEP 1.

Find a terminal with the APL operands. Then log on in the normal manner. Next type "APL", press enter; then press the alt key and the APL on/off key simultaneously. Then type the following:

```
") LOAD MANMOD"          /then wait;
SAVED 13:28:52 03/05/82
WSSIZE IS 414812         / then type;
") copy 2 apfns cms  "
"cms  "                  /wait;
CMS SUBSET
BEGIN RECORDING OF TERMINAL SESSION
R;                       / then type;
"RETURN"                 / wait;
APL                      /type;
") WSID"                 /wait;
IS MANMOD                /type;
```

STEP 2

"INPUT" /This opens the program for input data;

ENTER N (INITIAL CLASS VALUES):

This will be the initial stocks (numbers) of individuals that are in each year group selected for study. It is implicit that time is discrete and in practice will normally equal one year.

/enter the stocks making sure the numbers are correct.

"67193 51664 116942 175794 121322 77941 47167 13319 3745"

STEP 3

ENTER P (TRANSITION MATRIX) BY ROWS:

This is called the transition matrix and each row is called the position vector. It is implicit that these specifications are time discrete and are usually in year units. The elements of the vector will be assigned numerical values by making hypothetical assumptions or by estimating the probabilities from past data. The program requires one row for each stock value listed above. The main diagonal shows the percentage of individuals remaining in a year group. To the left of the main diagonal would be percentages designating those people that were demoted or lateral entry. On the right side of the diagonal would be percentages designating promotion rates.

/Enter your rows, insuring the numbers are correct.

ENTER 1TH ROW

.0572 .0937 .574 .0573 .0004 0 0 0 0

ENTER 2TH ROW

.0256 .0686 .406 .304 .0016 0 0 0 0

ENTER 3TH ROW

.0119 .0185 .185 .598 .0156 .0003 0 0 0

```
 ENTER 4TH ROW
 .0036  .0034  .0184 .493   .222   .0013   0      0      0
 ENTER 5TH ROW
 .0009  .0003  .0011 .0131  .673   .162    0      0      0
 ENTER 6TH ROW
 .0003  .0001   0    .0007  .0069  .782    .132   0      0
 ENTER 7TH ROW
 .0001   0      0    .0001  .0002  .0007   .821   .071   0
 ENTER 8TH ROW
  0      0      0     0      0     .0001   .0002  .764   .0593
 ENTER 9TH ROW
  0      0      0     0      0      0      0      0     .79

STEP 4
======

 ENTER NUMBER OF RECRUIT TYPE

     1   FIXED RECRUIT VECTOR
     2   ADDITIVE(RECRUIT SIZE)
     3   MULTIPLICATIVE(RECRUIT SIZE)
     4   ADDITIVE(SYSTEM SIZE)
     5   MULTIPLICATIVE(SYSTEM SIZE)
```

This gives the operator the chance to choose various types of recruitment systems. This thesis uses types 3, 4. For further information on this capability obtain a copy of Bartholomew and Forbes, "Statistical Techniques for Manpower Planning".

The following chart describes the inputs needed for the five different recruit types:

Recruit Types	Variables Needed
1	R
2	Rprop, Rsize, Inc
3	Rprop, Rsize, Fact
4	Rprop, Inc
5	Rprop, Fact

EXAMPLES:

ENTER RPROP(RECRUIT PROPORTION VECTOR)

".747 .0834 .1164 .0454 .0075 .0003 0 0 0"

ENTER ADDITIVE INCREASE

"10323"

ENTER RSIZE

"140,000"

ENTER FACT

"1.5" (150%); "1.2" (120%)

sk 1

note:

For further information use Bartholomew and Forbes as mentioned above.

/type in your choice.

STEP 5

ENTER PERCENT CODE

0 NO GRADE PERCENTAGES

1 GRADE SIZE AS PERCENT OF TOTAL GRADE SIZE

2 GRADE SIZE AS PERCENT OF ORIGINAL GRADE SIZE

The percentage calculation usually requested is #1. This number is located in the printout beside the total at the bottom.

/type your request.

STEP 6

DO YOU WISH TO SEE INTERVENING YEARS

0 NO

1 YES

If #1 is chosen and it is desired to produce a program that is calculated for 100 years, then the program will show the figures for 0 thru 100. If #0 is chosen, then only year 0,1 and 100 will be shown.

/type your choice.

STEP 7

END OF INPUT PROGRAM

Now it is time to get some output. Decide how many years of data that you desire to predict, and type "baseqn (x) ". For example, if you desire a ten year look, type "baseqn 10". The program will not print more than 999. Once a year has been selected, one cannot select that year or any preceding it until you have typed "reset" and presed enter. Note: Any of the variables may be changed following any run of Baseqn by direct assignment using APL language. All original variables are reassigned when the function "reset" is used.

STEP 8

/Next type;

"CMS" /then wait;

CMS SUBSET /then type;

"RECORD OFF" /wait,

END RECORDING OF TERMINAL SESSION

/the machine will also ask you what you desire to name the file/ and will place a copy on your disk.

EXAMPLE: of a file name is;
(baselina apl / or any FN FT under 8 characters each).

For further reference concerning APL:
APL-STAT: A Do-It-Yourself Guide to Computational Statistics Using APL, by Ramsey, J.B. and Musgrave, G.L.

APPENDIX D

BASELINE SCENARIO COMPUTER RUN

The following computer run was used to develop the discussion of the results concerning the Baseline Scenario as is reported in in Chapter IV. Note: refer to Appendix C for guidance in reproducing this run.
The following Manmod inputs were used:

```
   (N) 67193 51664 116942 175794 121322 77941 47167 13319 3745
   (P)
.0572  .0937  .574  .0573  .0004  0      0      0      0
.0256  .0686  .406  .304   .0016  0      0      0      0
.0119  .0185  .185  .598   .0156  .0003  0      0      0
.0036  .0034  .0184 .493   .222   .0013  0      0      0
.0009  .0003  .0011 .0131  .673   .162   0      0      0
.0003  .0001   0    .0007  .0069  .782   .132   0      0
.0001  0        0    .0001  .0002  .0007  .821   .071   0
       0        0     0      0     .0001  .0002  .764   .0593
       0        0     0      0      0     0      0      .79

 (TYPE)  (of recruitment)
         4(additive system size)
(RPROP)   .7101 .0875 .1304 .0614 .01 .0003 .0002 0 0
  (INC)   10323
```

FY 1981

PAY GRADE	STRENGTH LEVELS	(%)	RECRUITS
E 1	67193	(10)	
2	51664	(8)	
3	116942	(17)	
4	175794	(26)	
5	121322	(18)	
6	77941	(12)	
7	47167	(7)	
8	13319	(2)	
9	3745	(1)	
TOTAL	675087	(100)	10322

FY 1982

1	101627	(15)	
2	24265	(4)	
3	101823	(15)	
4	185872	(27)	
5	124526	(18)	
6	80982	(12)	
7	49032	(7)	
8	13522	(2)	
9	3748	(1)	
TOTAL	685397	(102)	132783

RPROP .6776 .091 .1427 .075 .0122 .0004 .0002 0 0
rprop= the recruit proportion vector.)

FY 1983

1	100563	(	14)	
2	26118	(	4)	
3	109944	(	16)	
4	177523	(	26)	
5	129007	(	19)	
6	83904	(	12)	
7	50965	(	7)	
8	13809	(	2)	
9	3763	(	1)	
TOTAL	695598	(	103)	135809

FY 1984

1	100975	(	14)	
2	26316	(	4)	
3	111511	(	16)	
4	178866	(	25)	
5	130324	(	18)	
6	86910	(	12)	
7	52937	(	8)	
8	14166	(	2)	
9	3792	(	1)	
TOTAL	705798	(	105)	136330

	FY 1985		
1	102015	(14)	
2	26535	(4)	
3	112352	(16)	
4	180677	(25)	
5	131572	(18)	
6	89479	(12)	
7	54954	(8)	
8	14579	(2)	
9	3835	(1)	
TOTAL	715997	(106)	137783
	FY 1986		
1	103159	(14)	
2	26812	(4)	
3	113450	(16)	
4	182333	(25)	
5	132865	(18)	
6	91696	(13)	
7	56948	(8)	
8	15037	(2)	
9	3895	(1)	
TOTAL	726194	(108)	139346

INC 6507

FY 1987

1	101745	(	14)	
2	26763	(	4)	
3	114137	(	16)	
4	183807	(	25)	
5	134110	(	18)	
6	93643	(	13)	
7	58877	(	8)	
8	15528	(	2)	
9	3968	(	1)	
TOTAL	732577	(	109)	137123

FY 1988

1	102239	(	14)	
2	26720	(	4)	
3	113578	(	15)	
4	184928	(	25)	
5	135309	(	18)	
6	95371	(	13)	
7	60718	(	8)	
8	16041	(	2)	
9	4056	(	1)	
TOTAL	738960	(	109)	137950

	FY 1989			
1	102884	(	14)	
2	26841	(	4)	
3	113894	(	15)	
4	185247	(	25)	
5	136380	(	18)	
6	96921	(	13)	
7	62457	(	8)	
8	16563	(	2)	
9	4155	(	1)	
TOTAL	745342	(	110)	138863
	FY 1990			
1	103527	(	14)	
2	26997	(	4)	
3	114504	(	15)	
4	185748	(	25)	
5	137199	(	18)	
6	98308	(	13)	
7	64090	(	9)	
8	17085	(	2)	
9	4265	(	1)	
TOTAL	751723	(	111)	139742

APPENDIX E

UNSTABLE ACCESSIONS SCENARIO COMPUTER RUN

The following computer run was used to develop the discussion of the Requirements Scenarios as is reported in Chapter IV. Note: refer to Appendix C for guidance to reproduce this run.
The following inputs were used:

```
(N)
 67193 51664 116942 175794 121322 77941 47167 13319 3745

(p)
 .0572 .0937 .574  .0573 .0004       0      0    0
 .0256 .0686 .406  .304  .0016       0      0    0
 .0119 .0185 .185  .598  .0156 .0003 0      0    0
 .0036 .0034 .0184 .493  .222  .0013 0      0    0
 .0009 .0003 .0011 .0131 .673  .162  0      0    0
 .0003 .0001  0    .0007 .0069 .782  .132   0    0
 .0001  0     0    .0001 .0002 .0007 .821  .071  0
 0      0     0     0     0    .0001 .0002 .764  .0593
 0      0     0     0     0     0     0     0    .79

(TYPE) 4
(RPROP)
 0.747 0.0834 0.116 0.0454 0.0075 0.0003 0 0 0
(INC)  8600
```

1981

PAY GRADE	STRENGTH LEVELS	(%)	RECRUITS
1	67193	(10)	
2	51664	(8)	
3	116942	(17)	
4	175794	(26)	
5	121322	(18)	
6	77941	(12)	
7	47167	(7)	
8	13319	(2)	
9	3745	(1)	
TOTAL	675087	(100)	8600

RPROP=.7101 .0875 .1304 .0614 .01 .0003 .0002 0 0

FY 1982

1	105240	(15)	
2	23577	(3)	
3	99763	(15)	
4	183669	(27)	
5	124181	(18)	
6	80981	(12)	
7	49006	(7)	
8	13522	(2)	
9	3748	(1)	
TOTAL	683687	(101)	131074

INC=-2000

FY 1983

1	100705	(15)	
2	24276	(4)	
3	106270	(16)	
4	170603	(25)	
5	127520	(19)	
6	83827	(12)	
7	50916	(7)	
8	13807	(2)	
9	3763	(1)	
TOTAL	681687	(101)	123283

INC=1900

FY 1984

1	101819	(15)	
2	24123	(4)	
3	105122	(15)	
4	168132	(25)	
5	126997	(19)	
6	86581	(13)	
7	52860	(8)	
8	14161	(2)	
9	3792	(1)	
TOTAL	683587	(101)	125052

INC=8200

FY 1985

1	106407	(15)	
2	24696	(4)	
3	106150	(15)	
4	166518	(24)	
5	126143	(18)	
6	88651	(13)	
7	54819	(8)	
8	14569	(2)	
9	3835	(1)	
TOTAL	691787	(102)	131142

INC=34900

FY 1986

1	127526	(18)	
2	27505	(4)	
3	112422	(15)	
4	168031	(23)	
5	125452	(17)	
6	90139	(12)	
7	56700	(8)	
8	15020	(2)	
9	3894	(1)	
TOTAL	726687	(108)	159034

INC=4100

FY 1987

1	111038	(	15)	
2	27805	(	4)	
3	124088	(	17)	
4	173496	(	24)	
5	125265	(	17)	
6	91189	(	12)	
7	58441	(	8)	
8	15498	(	2)	
9	3967	(	1)	
TOTAL	730787	(	108)	135142.

INC=7700

FY 1988

1	113119	(	15)	
2	26834	(	4)	
3	117447	(	16)	
4	182480	(	25)	
5	126567	(	17)	
6	91993	(	12)	
7	60008	(	8)	
8	15987	(	2)	
9	4053	(	1)	
TOTAL	738487	(	109)	138967

INC=8000

FY 1989

1	114868	(15)	
2	27060	(4)	
3	117452	(16)	
4	182882	(24)	
5	129359	(17)	
6	92844	(12)	
7	61401	(8)	
8	16471	(2)	
9	4150	(1)	
TOTAL	746487	(111)	141243

INC=5500

FY 1990

1	114057	(15)	
2	27139	(4)	
3	118416	(16)	
4	183234	(24)	
5	131325	(17)	
6	93964	(12)	
7	62657	(8)	
8	16940	(2)	
9	4255	(1)	
TOTAL	751987	(111)	140010.

APPENDIX F

ACTIVE DUTY ENLISTED REQUIREMENTS (FY 1982-1990)

The following Table was developed to show the active duty Enlisted requirements scenario for an Army of 18 Divisions. The paygrade percentages remain fixed across fiscal years.

TABLE XLII

ACTIVE DUTY ENLISTED REQUIREMENTS (FY 1982-1990).

# Divisions		16	16	16	16
FY		1982	1983	1984	1985
Pay Grade	(%)	Strength (000's)			
E1-E3	(27.7)	189.4	188.8	189.4	191.6
E4	(29.0)	198.3	197.7	198.2	200.6
E5	(19.2)	131.3	130.9	131.3	132.8
E6	(13.4)	91.6	91.3	91.6	92.7
E7	(7.9)	54.0	53.9	54.0	54.7
E8	(2.2)	15.0	15.0	15.0	15.2
E9	(.6)	4.1	4.1	4.1	4.2
TOTAL	(100.0)	683.7	681.7	683.6	691.8

# Divisions	17	17	17	17	18
FY	1986	1987	1988	1989	1990
Paygrade (%)		Strength (000's)			
E1-E3 (27.7)	201.3	202.4	204.6	206.8	208.3
E4 (29.0)	210.7	212.0	214.2	216.5	218.1
E5 (19.2)	139.5	140.3	141.8	143.3	144.4
E6 (13.4)	97.4	97.9	99.0	100.0	100.8
E7 (7.9)	57.4	57.7	58.3	59.0	59.4
E8 (2.2)	16.0	16.1	16.2	16.4	16.5
E9 (.6)	4.4	4.4	4.4	4.5	4.5
TOT (100.0)	726.7	730.8	738.5	746.5	752.0

Note: the percentage rates are held constant across fiscal years.

Source: The data for FY 1982-1987 came from the Army Program objective Memorandum (1983). FY 1988-1990 was projected from FY 1982-1987 data by the Author.

APPENDIX G

MANMOD APL PROGRAM (COMPUTER LANGUAGE)

```
      ▼INPUT[□]▼
      ▼ INPUT;I;K;PI;ERRMSG
[1]   ERRMSG←'ERROR: DIMENSION NOT COMPATIBLE WITH N-VECTOR.
      TRY AGAIN!'
[2]   I←1
[3]   'ENTER N(INITIAL CLASS VALUES)'
[4]   N←,□
[5]   K←ρN
[6]   'ENTER P(TRANSITION MATRIX) BY ROWS'
[7]   P←(K,K)ρ0
[8]  PINPUT:'ENTER ',(▼I),'TH ROW'
[9]   PI←,□
[10]  →INSERT×ι K=ρPI
[11]  ERRMSG
[12]  →PINPUT
[13] INSERT:P[I;]←PI
[14]  →PINPUT×ι K≥I←I+1
[15]  'ENTER NUMBER OF RECRUIT TYPE'
[16]  '      1   FIXED RECRUIT VECTOR'
[17]  '      2   ADDITIVE(RECRUIT SIZE)'
[18]  '      3   MULTIPLICATIVE(RECRUIT SIZE)'
[19]  '      4   ADDITIVE(SYSTEM SIZE)'
[20]  '      5   MULTIPLICATIVE(SYSTEM SIZE)'
[21]  TYPE←□
[22]  →(TYPE=1)/RPROPENTRY
[23] RV:'ENTER R(RECRUITMENT VECTOR)'
[24]  R←,□
[25]  RPROP←Kρ0
[26]  →NEXT×ι K=ρR
[27]  ERRMSG
[28]  →RV
[29]  →NEXT
[30] RPROPENTRY:'ENTER RPROP(RECRUIT PROPORTION VECTOR)'
[31]  RPROP←,□
[32]  →CHECK1×ι K=ρRPROP
[33]  ERRMSG
[34]  →RPROPENTRY
[35] CHECK1:→((TYPE=4)∨TYPE=5)/CHECK2
[36]  'ENTER RSIZE(INITAL RECRUIT TOTAL ENTERING SYSTEM)'
[37]  RSIZE←□
[38] CHECK2:→((TYPE=3)∨TYPE=5)/MULT
[39] ADD:'ENTER ADDITIVE INCREASE'
```

```
[40]  INC←⎕
[41]  →NEXT
[42] MULT:'ENTER MULTIPLICATIVE FACTOR'
[43]  FACT←⎕
[44]  R←K↑0
[45]  →NEXT
[46] NEXT:'ENTER PERCENT CODE'
[47]  '      0    NO GRADE PERCENTAGES'
[48]  '      1    GRADE SIZE AS PERCENT OF TOTAL GRADE SIZE'
[49]  '      2    GRADE SIZE AS PERCENT OF ORIGINAL GRADE SIZE'
[50]  PCODE←⎕
[51]  'DO YOU WISH TO SEE INTERVENING YEARS'
[52]  '      0    NO'
[53]  '      1    YES'
[54]  LINES←⎕
[55]  TCOUNT←0
[56] END:'END OF INPUT PROGRAM'
      ∇
```

```
      ∇OUTPUT[⎕]∇
      ∇ OUTPUT
[1]   I←0
[2]   →(TCOUNT>0)/CHECK
[3]  SETUP:PFORM←',⍞(⍞,I4,⍞)⍞'
[4]   FIRSTLINE←'I3,X3,I2,X,I9,X'
[5]   FIRSTLINE12←FIRSTLINE,PFORM
[6]   MIDLINE←'X6,I2,X,I9,X'
[7]   MIDLINE12←MIDLINE,PFORM
[8]   LASTLINE←'X4,⍞TOTAL⍞,I9,X'
[9]   LASTLINE←LASTLINE,PFORM,',I6'
[10]  ' T              N     PERCENT     R'
[11]  '================================'
[12] CHECK:→(PCODE= 0 1 2)/COLOUT0,COLOUT12,COLOUT12
[13] COLOUT0:I←I+1
[14]  →(I>K)/LAST
[15]  →(I>1)/MID0
[16] FIRST0:FIRSTLINE ⍙FMT TCOUNT,I,N[I]
[17]  →COLOUT0
[18] MID0:MIDLINE ⍙FMT I,N[I]
[19]  →COLOUT0
[20] COLOUT12:I←I+1
[21]  →(I>K)/LAST
[22]  →(I>1)/MID12
[23] FIRST12:FIRSTLINE12 ⍙FMT TCOUNT,I,N[I],PERCENT[I]
[24]  →COLOUT12
[25] MID12:MIDLINE12 ⍙FMT I,N[I],PERCENT[I]
[26]  →COLOUT12
[27] LAST:LASTLINE ⍙FMT TOTAL,TOTPERCENT,RSUM
[28]  '--------------------------------'
      ∇
```

```
      ▽BASEQN[□]▽
      ▽ BASEQN T
[1]    →(TCOUNT=0)/SETUP
[2]    →(T<TCOUNT)/ERROR1
[3]    →START
[4]   SETUP:N←N
[5]    RPROP←RPROP
[6]    TYPE←TYPE
[7]    P←P
[8]    ONE←(K←⍴N)⍴1
[9]    ANSWER←0 ROUND 0,(1,K)⍴NINT←N
[10]   TOTAL←TOTAL←ONE+.×N
[11]   RECRUIT 0
[12]   R←R
[13]   →OUTPUTDATA
[14]  START:NINT←N+.×P
[15]   TCOUNT←TCOUNT+1
[16]   RECRUIT TCOUNT
[17]   ANSWER←ANSWER,[1] 0 ROUND TCOUNT,N←NINT+R
[18]   TOTAL←⌊(0.5+ONE+.×N)
[19]   →((TCOUNT=T)∨LINES=1)/OUTPUTDATA
[20]   →START
[21]  OUTPUTDATA:TOTAL←⌊(0.5+ONE+.×N)
[22]   TOTPERCENT←⌊(0.5+100×TOTAL DIV TOTAL)
[23]   RSUM←⌊(0.5+ONE+.×R)
[24]   →(PCODE= 1 2)/PCALC1,PCALC2
[25]   →SKIP
[26]  PCALC1:PERCENT←⌊(0.5+100×N÷TOTAL)
[27]   →SKIP
[28]  PCALC2:PERCENT←⌊(0.5+100×N÷TOTAL)
[29]  SKIP:OUTPUT
[30]  CHECK:→(TCOUNT<T)/START
[31]   →0
[32]  ERROR1:'TIME REQUESTED HAS BEEN PAST'
[33]   →0
       ▽
```

```
      ▽RESET[□]▽
      ▽ RESET
[1]    TCOUNT←0
[2]    N←N
[3]    RPROP←RPROP
[4]    TYPE←TYPE
[5]    P←P
[6]    'RESET COMPLETED'
       ▽
```

```
      ∇RECRUIT[□]∇
      ∇ RECRUIT T
[1]    →(TYPE∈ 1 2 3 4 5)/OUT,ADDREC,MULTREC,ADDSYS,MULTSYS
[2]    'INVALID OR MISSING RECRUIT TYPE CODE'
[3]    →0
[4]   ADDREC:R←(RSIZE+T×INC)×RPROP
[5]    →0
[6]   MULTREC:R←(RSIZE×PACT*T)×RPROP
[7]    →0
[8]   ADDSYS:R←(INC+TOTAL-NINT+.×ONE)×RPROP
[9]    →0
[10]  MULTSYS:R←(((PACT-1)×TOTAL)+TOTAL-NINT+.×ONE)×RPROP
[11]   →0
[12]  OUT:→0
      ∇
```

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